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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The Brooklyn drydock work, for the U. S. Navy Department, is to be re-advertised, say Washington dispatches. At the letting of some months ago bids ranged from $412,000 to $674,000, and the passage of the eight-hour labor law since then has complicated the situation, especially as the lowest bid had not been favorably accepted at the time the labor law was signed by the President.

The new 10-in. pneumatic gun-carriage was again successfully tested at Sandy Hook, recently. The gun was a 30-ton high-power breech-loader. The tests were for range of recoil chiefly. At an elevation of 3° and with 190 lbs. of power, the recoil stopped 13 ins. short of the buffers; at 5° it reached within 7 ins., and at 6° within 3 ins. The machinery is simple and easily handled and the operating of loading and firing took but little over one minute, says the "New York "Tribune."

The Merwede Canal, connecting Amsterdam with the Rhine, was opened in its first section of 28 miles on Aug. 4. This canal, when completed, will be 48½ miles long, 100 ft. wide and have a depth of 10½ ft. It will take the place of the old Cologne waterway and crossing the Leyden Rhine, passes Utrecht and enters the Leck near Vreeswyk. The second section is still under construction, and leaving Vreeswyk enters the Merwede, one of the branches of the Maas and Waal Delta, near Gorinchem.

Reproductions of the original locomotive drawings of George Stephenson have been sent by the present house of George Stephenson & Co. to the Baltimore & Ohio's exhibit of the railways of the world for the Columbian Exposition. These drawings include facsimiles of the working plans of the "Rocket," "Lancashire Witch," "Northumbrian" and other famous locomotives of 1829-31. Among them are the plans of the Saratoga & Schenectady engine of 1833, and the "Brother Jonathan," of the Mohawk & Hudson Railroad. It is said that this is the first time these plans have been reproduced.

An attempt is to be made, says Paris dispatches, to prevent the lapsing of the Panama Canal Concessions, by forming a new company with "a capital of $30,000,000." M. Hielard, Vice-President of the Paris Chamber of Commerce, is mentioned as the head of the syndicate. It is proposed to spend this money on the Chagres River work and at the Culebra cut, and thus open 45 of the 70 kilometers of the canal." And what then?

The most serious accident of the week was a head collision Aug. 30, at Whitehill, N. J.., on the Camden & Amboy line of the Pennsylvania R. R. An eastbound passenger train collided with an extra train of empty passenger cars and both engines were wrecked. Three men were killed and another was fatally injured The accident is attributed to a mistake of the dispatcher, or carelessness on the part of the engineman of the extra train in not sidetracking for the regular train.

A trestle on the Minneapolis, St. Paul & Sault Ste. Marie Ry., near Barrett, Minn., gave way under a passenger train, Aug. 27, and it is reported that 6 persons were killed and 11 injured. According to press dispatches the trestle was 256 ft. long and 12 ft. high, and the train was running very slowly. Three cars went down. It is also said that the structure had been undermined by the recent heavy rains. We expect to give more complete and official particulars in a later issue.

The stand-pipe, 70 ft. high, connected with the new water-works at Nappanee, Ind., burst last week, wrecking the pump-house and damaging adjoining houses. The town had not accepted the structure. Superintendent Wm. Burns was seriously injured. The cause of the failure is not stated.

The Cataract Construction Co., of Niagara Falls, is discussing the transmission of power to Buffalo and elsewhere, from both the American and the Canadian tunnels. As before stated, the English experts, Prof. George Forbes, Consulting Electrical Engineer, and Prof. W. C. Unwin, Constructing Hydraulic Engineer, of the company, are now in consultation with the Executive Committee of Directors. It is now officially stated that the company is convinced that it can provide electrical power to Buffalo cheaper than it can be produced in that city, and that this power will soon be for sale there. The tunnel is now practically completed, but there is still considerable work to be done on the hydraulic canal, the main wheel-pit and the shafts and connecting subways. Jan. 1, 1893, is named as the earliest probable date for admitting water to the tunnel.

Florida phosphate miners are rejoicing over a rise in the price of their product. Following the discoveries of phosphate in the state two years ago the mines were rapidly developed and such a large quantity of phosphate rock was thrown on the market last year that buyers had everything their own way and prices fell to a point where few miners could make any profit. The low prices continued long enough to eliminate many of the weak companies and speculative concerns from the field, and the production was reduced below the market demand. The rise in price has followed as a natural consequence.

Electrical distribution of power has been adopted in the Sheridan Building, at Denver, Colo., a structure erected for tenants engaged in light manufacturing. The building contains about 20 rooms above the basement, arranged for watch case makers, model makers and similar trades. The power plant is located in the basement and consists of two 60-in. return tubular boilers, one 65-HP. Corliss engine and one 50-HP. Straight Line engine. An 80-K-W. C. & C. dynamo is driven by the larger engine through a a countershaft, and a dynamo of one-fourth the size is belted direct to the other engine. The larger engine and dynamo are for use during the day and the smaller for use after 6 p. m. The potential used in 110 volts. A switchboard in the engine room enables a current to be directed into the circuit leading to each tenant's motor, and ampere meters record the amount of power used on each circuit. The building is of course lighted throughout by electricity. The steam power plant was furnished by Messrs. Fraser & Chalmers, of Chicago.

A steep grade on the San Francisco & San Mateo electric railway, the first electric line in San Francisco, is operated in a decidedly novel manner. The road is double track and has one grade of 11⅜% and another of 14%. The former is operated in the usual manner, but before reaching the 14% grade the up track makes a detour and climbs the hill by a longer route on an easier grade. The down track runs straight down the hill, and for about 600 ft. has a 14% grade. A conduit is built beneath the track, in which runs a carriage carrying a counterbalance weight. When a car reaches the top of the hill a ½-in. wire rope is fastened to the rear drawbar. This rope passes several times around a drum and runs down the conduit, the other end being attached to the counterbalance carriage. As the car descends the grade its speed is controlled by an attendant at the top who holds the lever of a band brake on the winding drum. When the car reaches the bottom the rope is detached and the attendant allows the counterbalance carriage to run back down the conduit by its own gravity ready for use with the next car. The cars on this line, as on nearly all the San Francisco street railways, have track brakes as well as the usual wheel brakes.

The cars for the Liverpool Overhead Railway Co., of Liverpool, England, are described in a recent issue of the "Railway World." The cars are 45 ft. long, 8 ft. 6 ins. wide, carried upon two 4-wheel trucks, 32 ft. apart between centers of truck pins. Truss rods are used as in American cars. The truck frames are of pressed steel, and the wheels are 33 ins. in diameter, with steel tires and wrought iron spokes. Each truck has a 70 to 100-HP. electric motor, supplied by the Electric Construction Co., of Wolverhampton. A central automatic coupler and buffer arrangement is used. The ends of the car are closed, and the interior is divided into two main compartments—first and second class, with one door in each side of each compartment. There is also a separate smoking compartment. Each car has seating accommodation for 56 passengers. The framing is of oak and teak. The interior finish is of oak and walnut for the first class, and yellow pine for the second class. The roof is arched, and has no clearstory. Each train will consist of two cars. The cars are lighted by electricity, and are fitted with hand brakes, as well as the Westinghouse automatic brake, the arrangement for the latter being similar to that of the locomotives and cars of the City & South London Ry., the underground electric railway. The cars are being built by Brown, Marshalls & Co., of Birmingham.

Four iron light ships have recently been built by F. W. Wheeler & Co., of West Bay City, Mich., for the U. S. Lighthouse Board. They are 118 ft. 10 ins. long, 26 ft. 6 ins. beam, 14 ft. 6 ins. depth of hold, 8 ft. draft, and 350 tons displacement. To ease the strain on the cable in rough weather, or to return to the station, the boats are fitted with compound engines, having cylinders 14 and 24 ins. diameter by 16 ins. stroke. The screw is 6 ft. diameter. There are two return tubular boilers, 8 ft. diameter and 9 ft. long, each with a 36-in. Fox corrugated furnace, and 96 tubes 6 ft. 7 ins. long and 3 ins. diameter. The sea speed is 9 knots. They will be the first light ships to use the electric lights. The electric plant consists of two horizontal high speed engines of 8 H.P. with 70 lbs. of steam, from which power is transmitted by two Evans friction cones to two compound-wound Thomson-Houston dynamos, 60 amperes capacity, having an electromotive force of 110 volts and a commercial efficiency of 80%, supplying electricity to 8 arc lights of 100 c. p. and 20 incandescent lights of 16 c. p., the former lighting the two signal lanterns situated on the masts, 49 ft. above the deck, and the latter distributed about the vessel. There is a 1,000-lb. fog bell, operated by hand. The fog whistle is 12 ins. diameter, worked by a machine consisting of a horizontal non-condensing engine with cylinder 5×6 ins., which, through a worm gear turns a cam wheel 20 ins. in diameter. The cam works against a small roller in the middle of the lever, one end of which is attached to the balanced whistle valve, the distance between the cams determining the interval between blasts. It is said that on a calm day this whistle can be heard 15 miles.

The molasses fuel question is again being agitated in Louisiana. At the present time common molasses is hardly salable at 2 cts. per gallon and "The Planter" claims that it is only worth $3.33 per ton on the plantation and is then cheaper than coal. As compared with average coals the same journal says that molasses contains 8% ash, 20% water and 72% carbon (60% saccose and glucose and 12% gums). It would thus make an excellent fuel with the proper devices for burning liquid fuel. In Cuba considerable quantities of molasses have been used as fuel with success by spraying it over the "bagassee" or crushed cane as the latter enters the furnaces. But, as "The Planter" says, that the molasses product of 1892, in Louisiana, will amount to only 120,000 tons, and the greater part of this is otherwise very useful, the amount left for fuel is small.

Erratum.—In the diagrams for discharge of pipes, published in our issue of Aug. 11 (p. 127), accompanying a paper by Prof. A. N. Talbot, the decimal points along the horizontal axis of the lower or second diagram were misplaced for the values below 1.0, from 0.005 to 0.09, inclusive, which should read 0.05 to 0.9, inclusive, both at top and bottom of the second diagram. The values on the first diagram, and on the further half of the second diagram, were correct. The error was committed by our draftsman, in changing the gradients to grades per cent., instead of per unit, as they were given on the originals; in accordance with an absurd foreign custom, which we take leave to say is much more honored in the breach than the observance, and by no means a standard or warranted practice in this country, as the custom of expressing all grades in terms of the per cent. is well established here, and in every way preferable.

WORLD'S COLUMBIAN EXPOSITION.

(With inset.)

Manufactures and Liberal Arts Building.

One of the most striking features of the Exposition will be the enormous building provided for the departments of Manufactures and Liberal Arts, and the exterior and interior appearance of this building will undoubtedly be impressed strongly upon the memories of all visitors, as the sight of a building 1,687 ft. long, with an interior court spanned by a great arched roof 268 ft. wide and 210 ft. high is not likely to be easily forgotten, especially when combined with graceful and artistic design and decoration. It will be the largest building of the Exposition, and in fact it is stated that it will be the largest building in the world, and have the largest area under one roof of any building ever constructed. It is rectangular in plan, 1,687 ft. long by 787 ft. wide, covering an area of 30½ acres, while the floor area, including galleries, will be nearly 40 acres. The great interior court is 1,276 ft. long by 380 ft. wide. The building is upon the lake front, as shown upon the map in our issue of Jan. 16, and its general appearance was illustrated and described in our issue of Feb. 13. The architect was Mr. George B. Post, of New York, and the structural work was designed by Mr. D. H. Burnham, Chief of Construction, and Mr. E. C. Shankland, Engineer of Construction.

It was originally intended to have an open court, about 1,275 × 375 ft., in the middle of the building, with a great dome 370 ft. diameter in the center of this court, but in consequence of the great demand for space it was decided to cover in this court, and the contract for the dome was therefore canceled. The building is in the Corinthian style of architecture. The main fronts are exceeding simple in treatment, but are imposing from their long array of massive columns and bold arches, which are relieved by elaborate decoration. There are four principal entrances, one in the middle of each side, and each entrance consists of a central archway 40 ft. wide and 80 ft. high, with smaller side arches. Over the portals is the attic story, decorated with sculptured eagles 18 ft. high, while over the side arches are panels bearing inscriptions, with the spandrels filled in with figures in bas relief. At each corner of the building is a pavilion with arched entrances. The arches of the main front will have the upper part filled in with glass, while the lower portion, up to the level of the gallery floor, will be open, forming a loggia or arcade 25 ft. wide and 25 ft. high, fronting on the lake. The central structure is of steel, and the surrounding part of timber construction with combination roof trusses. The roofs will be covered with corrugated iron and provided with ample skylight area. The exterior covering and decorative work is of staff, a cement plaster which has already been described in our columns, and is used for all the main buildings on account of the rapidity and cheapness with which it can be made, and the excellent appearance which it gives in the finished structure, while it is easily molded into the most elaborate decorative work. The color of the exterior of the building will be a strong ivory, resembling the Travertine stone used in Rome.

The foundations will be of a similar character to those of the Machinery Building, illustrated in our issue of July 7. The floor will be 12 ft. above datum, and the average load upon the floor is taken at 100 lbs. per sq. ft., but under exhibits of exceptional weight the foundations and floor will be strengthened. The general design of the foundations and floors was described in our issue of March 5.

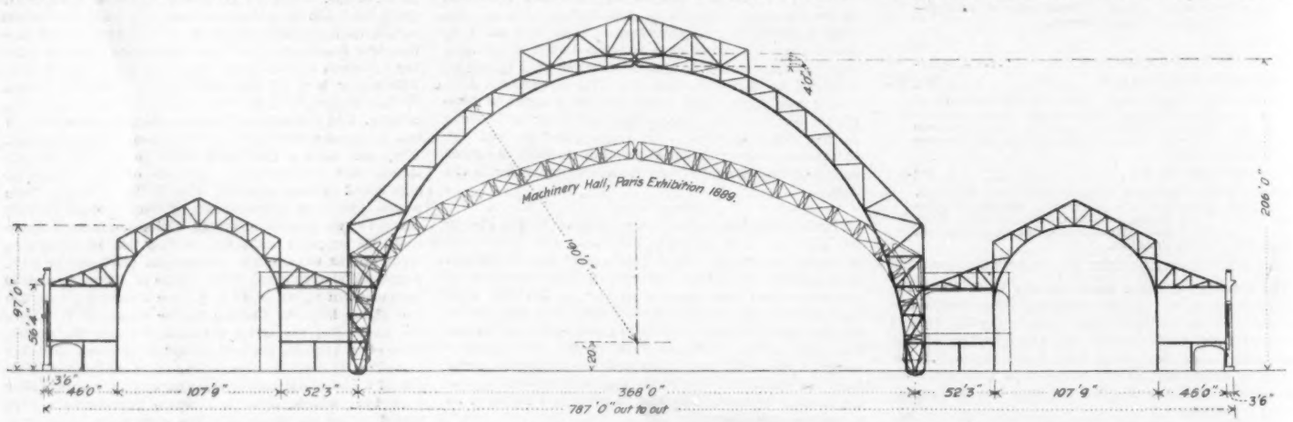
In the center of the building will be the enormous hall, 1,275 ft. 10 ins. long by 380 ft. wide, free from columns, and covered by a roof formed by the great steel and trusses to be described later, which rise to a height of 210 ft. above the floor. This space will be lighted by clearstory windows and by the skylight area of the roof covering. Around this hall, inclosing it on every side, is the exterior building, over 200 ft. wide. This consists of a middle nave, 107 ft. 9 ins. wide and 115 ft. high, with an aisle on each side. The aisle next the main hall is 52 ft. 3 ins. wide, and the aisle on the outer side of the building 46 ft. wide. Each aisle will have a gallery floor, 25 ft. above the main floor. The proportion of skylight to roof is 50%, and it is intended in this, and in all the main buildings, to put curtains under the skylights so as to screen the interior from the sun during very hot weather. Ventilation will be provided for by louvres in the sides of the clearstory roof. The ironwork of the main roof is oiled and will not be painted. The trusses of the exterior building are of combination construction. The roof will be of corrugated iron. The ironwork of the main roof is completed, and the sheathing boards are following up the ironwork very closely. The other work is rapidly approaching completion on the exterior, and the progress of the whole building is reported as extremely satisfactory. This building, and all the other main buildings, we are officially informed, will be ready for the dedicatory ceremonies in October. The interior will be lighted by arc lamps and 10,000 incandescent lamps. The original estimate was $1,000,000, which was for the original plan with an open court, and did not include the great arched roof which was provided for later, as already noted, and the total cost of the building is over $1,500,000. We are indebted to Mr. E. C. Shankland, Engineer of Construction, for the following particulars in regard to the construction contracts, and in our issue of Jan. 16 it was stated that the iron work of the roof of the main court was let at 4.1 cts. per lb.

Main Court:	
Ironwork; Edge Moor Bridge Works, Wilmington, Del.; 13,000,000 lbs.	$530,000
Roofing and Skylight; James A. Miller & Bros., Chicago	99,962
Total for Main Court	$629,962
Exterior Building:	
Carpentry; the trusses are all combination, and the approximate amount of iron in them is 2,000 tons, furnished by the carpentry contractor, and included in his contract; Agnew & Co., Chicago	$634,870
Roofing and Skylight; the roof will be of corrugated iron; James A. Miller & Bros., Chicago	119,142
Painting and Glazing; W. H. Stubbings & Co., Chicago	23,746
Lathing and Plastering; Barnett, Record & Chapman, Minneapolis, Minn.	14,800
Exterior Covering; Smith, Crimp & Eastman, Chicago	178,000
Architectural Modeling; Karl Bitter, New York, Sculptor	7,150
Plaster Models; Ellin Kitson & Co., New York,	15,075
Decoration; Walter McEwen, Paris; $6,000, and Gari Melchers, Paris, $6,000	12,000
Total for Exterior Building	$999,783
Grand total	$1,629,745

The most important structural work is the steel arch roof of the main court, which was designed by Mr. E. C. Shankland, Engineer of Construction, and built by the Edge Moor Bridge Works, of Wilmington, Del., under the general specifications given in our issue of March 26. No particular process of manufacture was specified, but the steel was not to contain over .08% of phosphorus, and the test pieces were to show a tensile strength of 60,000 to 68,000 lbs. per sq. in., an elongation of at least 24%, and a reduction of area of at least 40%. The vertical load on the roof is estimated at 30 lbs. per sq. ft. (horizontal) for dead load of roof, and 12 lbs. per sq. ft. (horizontal) for snow. The wind load is estimated at 30 lbs. per sq. ft. of area perpendicular with a direction of wind 20° above the horizontal.

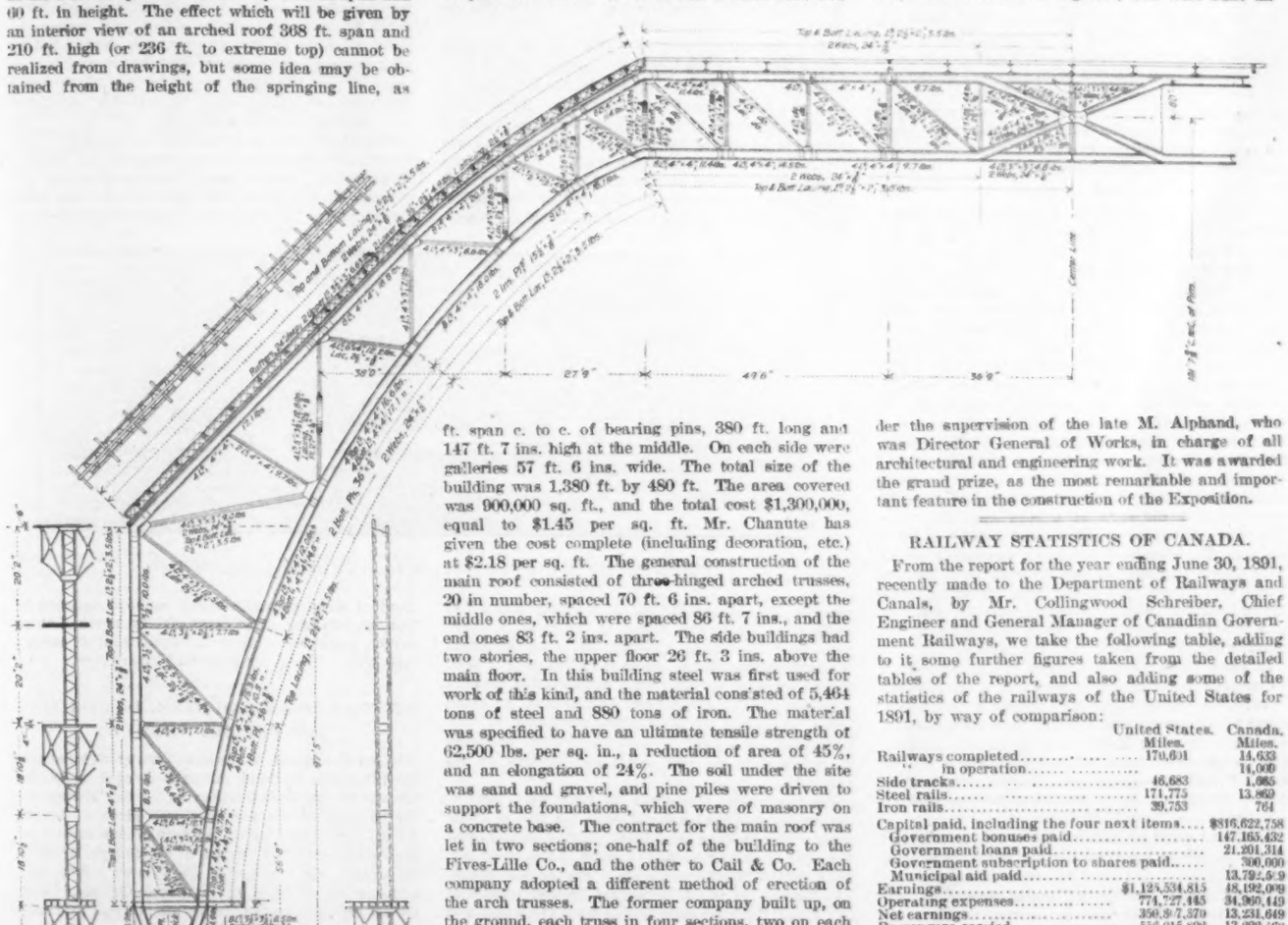
There are 18 main arched trusses A, of the three-hinged type, 368 ft. span c. to c. of shoe bearings, and 380 ft. out to out of trusses. These are spaced 50 ft. apart, c. to c., except the middle pair, which are 73 ft. 6 ins. apart. Above these trusses is a clearstory roof 21 ft. high and 152 ft. wide, with louvres in the side. The height from the floor to center of pin bearing at the crown of the arch is 206 ft. 4 ins.; to top and bottom chords of truss at the crown 202, ft. and 210 ft. respectively; and to top of clearstory roof 236 ft. 6 ins. From the crown of each end arch truss run two diagonal arch trusses D toward the corners of the building, and the triangular spread of roof between these is carried by a special arch truss C, having a flat top. The arch trusses are connected by trussed purlins, 50 ft. apart, which carry trussed rafters 12 ft. 6 ins. apart, parallel with the arches, and upon these again are 4 × 8 in. wooden jack rafters, parallel with the lower axis of the building, to which the 1 × 6 in. wooden roof sheathing is fastened. The outer chord of each main arch is vertical to a height of 96 ft. 8 ins., above which it rises by a curve of 190 ft. radius. The curve of the inner or lower chord begins at a height of 20 ft. above the floor. The width of truss at the base is 14 ft. and the depth at the crown 8 ft. The chords are about 3 ft. square, built up in general of four top angles, four bottom angles, two side or web plates, and top and bottom lacing. The web members are mainly of angles, sometimes with and sometimes without lacing, and in some places having web plates. The pins of the shoe bearings are 8 ins. diameter, and those at the crown bearings are 5 ins. diameter. The shoes of each truss are connected by two rods 2 ins. square, except the trusses C, which have four 1 15-16-in. rods.

The general structural arrangement of the building, as well as the construction of the trusses and other parts, are clearly shown by the drawings on our inset sheet. An illustration of one of the completed arch trusses was given in our issue of May 12 (where, however, the span was wrongly printed as 328 ft. instead of 368 ft.), and in our issue of July 28 we described and illustrated in detail the interesting method of erection of these great trusses. In regard to the method of transporting the material, the Edge Moor Bridge Works inform us that the top and bottom chords were spliced at each joint, and all the web members were shipped loose, which made it possible to forward the material in the ordinary manner.



COMPARATIVE CROSS SECTION OF THE MANUFACTURES BUILDING, CHICAGO, AND THE MACHINERY HALL, PARIS.

From the foregoing description, and from an examination of the accompanying drawings and the general elevation (Eng. News, Feb. 13), it will be seen that this enormous building has been treated most successfully, both in regard to its architectural and structural features. Mr. George B. Post, the architect, is to be complimented upon the bold and imposing appearance of the long extent of the main fronts, with their array of arches and columns, broken only by the main entrances and the corner pavilions, while above is the great sweep of the roof of the inner court. Mr. Shankland, the engineer, and the designer of the roof of this court, may pride himself upon being the designer of the greatest roof in the world, exceeding that of the Machinery Hall at the Paris Exposition of 1889 by 4 ft. in span and 60 ft. in height. The effect which will be given by an interior view of an arched roof 368 ft. span and 210 ft. high (or 236 ft. to extreme top) cannot be realized from drawings, but some idea may be obtained from the height of the springing line, as



Details of Arched Truss "C."

marked on the general cross section, which is 20 ft. above the floor.

The next largest roof is that of the Machinery Hall at Paris, with three-hinged arched trusses, 264 ft. span and 147 ft. high. The comparative proportions of the Chicago and Paris roofs are shown on the accompanying cross section, and some of the particulars of the Paris building we again describe as of interest in connection with this new rival. Next comes the trainshed of the terminal station of the Pennsylvania R. R. at Jersey City, N. J. This is also carried by three-hinged arch trusses, 252 ft. 8 ins. span, c. to c. of shoe pins, and 89 ft. 9¼ ins. high to top of truss, or 113 ft. 9¼ ins. to extreme top of clearstory. This trainshed was described and illustrated in our issue of Sept. 26, 1891. Next again comes the trainshed of the St. Pancras terminal station of the Midland Ry., in London, England. This has rigid arch trusses, 240 ft. clear span and 100 ft. clear height above the rails. The trusses are 6 ft. deep, and spaced 29 ft. 4 ins. apart c. to c., with intermediate ribs carried by trussed purlins at intervals of 18 ft. 6 ins. This trainshed is 690 ft. long, and was opened in 1868. It covers five platforms, ten tracks and a 25-ft. carriageway. The Machinery Building at Chicago has three parallel rows of three-hinged arches, 130-ft. span and 93 ft. 6 ins. high. This building was described and illustrated in our issue of June 30. All these great roofs have the bearings of the trusses at or near the floor level.

Machinery Hall, Paris, 1889.

The outline of this great building at the Paris Exposition of 1889 is shown upon the accompanying comparative cross-section. It had a main roof 364 ft. span c. to c. of bearing pins, 380 ft. long and 147 ft. 7 ins. high at the middle. On each side were galleries 57 ft. 6 ins. wide. The total size of the building was 1,380 ft. by 480 ft. The area covered was 900,000 sq. ft., and the total cost $1,300,000, equal to $1.45 per sq. ft. Mr. Chanute has given the cost complete (including decoration, etc.) at $2.18 per sq. ft. The general construction of the main roof consisted of three-hinged arched trusses, 20 in number, spaced 70 ft. 6 ins. apart, except the middle ones, which were spaced 86 ft. 7 ins., and the end ones 83 ft. 2 ins. apart. The side buildings had two stories, the upper floor 26 ft. 3 ins. above the main floor. In this building steel was first used for work of this kind, and the material consisted of 5,464 tons of steel and 880 tons of iron. The material was specified to have an ultimate tensile strength of 62,500 lbs. per sq. in., a reduction of area of 45%, and an elongation of 24%. The soil under the site was sand and gravel, and pine piles were driven to support the foundations, which were of masonry on a concrete base. The contract for the main roof was let in two sections; one-half of the building to the Fives-Lille Co., and the other to Cail & Co. Each company adopted a different method of erection of the arch trusses. The former company built up, on the ground, each truss in four sections, two on each side of the building. The two side sections, up to the beginning of the flat roof, were built outside the building line, and hoisted into position by tackle from a central traveler, assisted by a traveler inside the building line, the section of the truss turning upon its shoe bearing as a pivot. Two of these side travelers were used, one on each side of the building, and each carried two traveling cranes for hoisting the lighter material. The two upper sections were then raised by tackle from the central traveler at one end and from the side traveler at the other end. The center pin bearing was then fitted, and the junction of the two sections on each side riveted up. Each truss complete weighed 196 gross tons, except the end trusses, which were 240 tons. The weight of the purlins, rafters, sash bars, etc., in each bay was 124 tons, and the weight of other iron work in each bay was 46 tons. The operation of raising and fixing occupied about five hours, and the gang for each side of the building consisted of 6 men at the upper hoisting machine, 5 men at the lower hoist, and 19 fitters, carpenters, etc., making a total of 80 men for the whole truss. The first bay was completed in 23 days, the second in 16 days, the third in 12 days, and the other in 10 days each. Cail & Co. used a complete falsework, and built up each truss in place, hoisting up the work in sections weighing not over 3 tons each. About 215 men were employed daily. The first few bays were erected at the rate of 13 and 12 days each, and the remainder in 10 days each. The shoe bearings were not circular pins, but hollow cast iron bars and flat bottom, vertical sides and rounded top, and the whole surface of the roof was supported on about 302 sq. ft. of bearing surface. The shoe bearings of the trusses were not connected by the rods as in the other large buildings previously referred to. The side galleries were roofed by arches at right angles to the main arches, their span being equal to the distance between the main trusses. The main roof was glazed from the ridge to the level of the gallery roofs. This building and its great roof were designed by M. Dutert, the architect and engineer, and were built under the supervision of the late M. Alphand, who was Director General of Works, in charge of all architectural and engineering work. It was awarded the grand prize, as the most remarkable and important feature in the construction of the Exposition.

RAILWAY STATISTICS OF CANADA.

From the report for the year ending June 30, 1891, recently made to the Department of Railways and Canals, by Mr. Collingwood Schreiber, Chief Engineer and General Manager of Canadian Government Railways, we take the following table, adding to it some further figures taken from the detailed tables of the report, and also adding some of the statistics of the railways of the United States for 1891, by way of comparison:

	United States. Miles.	Canada. Miles.
Railways completed	170,601	14,633
" in operation		14,009
Side tracks	46,683	1,665
Steel rails	171,775	13,869
Iron rails	39,753	764
Capital paid, including the four next items		$316,622,758
Government bonuses paid		147,165,432
Government loans paid		21,201,314
Government subscription to shares paid		300,000
Municipal aid paid		13,794,579
Earnings	$1,124,534,815	48,192,009
Operating expenses	774,727,445	34,960,149
Net earnings	350,807,370	13,231,649
Passengers carried	556,015,502	13,222,568
Tons of freight	704,298,609	21,753,230
Passenger train mileage	320,712,913	14,987,647
Freight " "	493,541,909	23,594,370
Mixed " "	16,918,394	4,819,161
Total " "	831,202,376	43,399,178
Engine mileage		56,950,343

	Canada.	
Locomotives (U. S., 33,563)	1,800 owned;	50 hired.
Sleeping and parlor cars	125 "	17 "
First-class cars	818 "	31 "
Second-class and immigrant cars	609 "	15 "
Baggage, mail and express cars	535 "	25 "
Stock and box freight cars	30,740 "	3,675 "
Flat cars	14,925 "	280 "
Coal and dump cars	5,437 "	122 "
Grain elevators		42
Guarded level crossings		131
Unguarded " "		8,708
Track crossings at grade		193
Overhead bridges		384
Junctions with other lines		207
" " branch "		187
Passengers killed		13
Total persons killed		195
" " injured		818

One of the tables in Mr. Schreiber's report gives particulars of the track of each railway, from which it is seen that standard gage is practically universal. The weight of steel rails on main lines averages from 56 to 60 lbs. per yd. in general, though there are a few of 72 to 80 lbs. per yd. Fish plates and angle bars are the most usual methods of joint fastenings; chairs are used in one instance and the Fisher bridge joint in one instance. The number of ties per mile seems to average 2,640 to 3,000.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 170.)

Purification in the Drainage Area of the Boston Water-Works.

In our issue of Aug. 4 an account was given of the efforts which have been made by the city of Boston to exclude sewage from its water supply. Since these efforts were begun systems have been constructed at South Framingham and Marlborough, Mass., in connection with which are the sewage purification plants described in our issues of Aug. 11 and 18, respectively. A sewerage system is being built at Westborough in connection with which intermittent downward filtration is proposed as a means of purifying the sewage. A description of this plant is deferred until after it has been put under construction or in operation. Mr. Chas. A. Allen, M. Am. Soc. C. E., Worcester, Mass., is the engineer for the whole system at Westborough.

A chemical precipitation plant operated by the city of Boston to purify the sewage of some tanneries located in the Mystic division of the water-works is of interest and will also be described in a later issue. It was constructed under the direction of the city engineer of Boston, Mr. Wm. Jackson.

Greenfield, Mass.

A few words may be said regarding the sewage disposal of this town. It appears that the method adopted was designed to utilize the sewage and with no idea of purifying it, but as the same plan with slight elaboration might often be employed, and in Europe is so employed, both for utilization and purification, a brief description of it will not be out of place.

The population of Greenfield in 1890 was 5,252. Water-works were built by the fire district in 1870. A main sewer was built about ten years ago. It seems that when this sewer was built the owner of some meadow land arranged to have the sewage brought to the land, which was near a stream of considerable size. The outfall sewer, a circular brick sewer about 2 ft. in diameter, was therefore abruptly terminated at the edge of a road embankment a few feet above the meadow, and beside a small stream. The mouth of the sewer was rudely closed with plank and the sewage diverted to a wooden flume and thence to a sewer pipe extending down the embankment, and, apparently, out on the meadow to a hole in the ground. Ditches extended over the meadow for the distribution of the sewage.

In June, 1892, when the writer visited Greenfield, no efforts were being made to control the flow of the sewage, the owner of the land having recently died. Some of the sewage was leaking from the flume and sewer pipe, flowing directly into the brook, and some was going down onto the meadow. Parts of the meadow had apparently been flooded with sewage during the spring. In places the grass was growing luxuriantly.

So far as could be learned, the owner of the land gained an advantage from putting the sewage upon it while he lived, and since his death the matter has been neglected. The Town Clerk of Greenfield, Mr. F. L. Greene, thinks that the sewage of the town has increased beyond the capacity of the land.

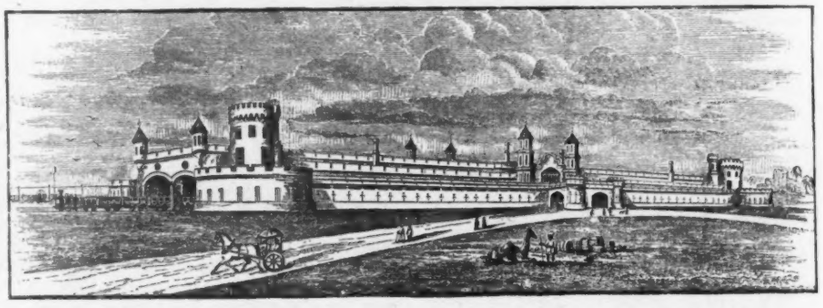
Through neglect the outfall end of the sewer, in June, was in a very objectionable condition. It is close by two or three houses, and deposits of solid matter were putrefying and giving rise to very offensive odors. But this, it must be remembered, is all owing to improper construction and neglect.

In the West the sewage of several cities is used during the summer months for irrigation, more to eke out scanty water supplies than to fertilize the crops by applying sewage. Why cannot the same thing often be done in the East, where a gravity outfall sewer and tillable land can be brought together? This might not often be practicable except in connection with small towns, but growing demands for sewage purification will make the idea worthy of consideration in at least a few communities. It often happens that crops are light in the East through lack of rain, when there is sewage which might at a nominal expense be diverted to some of the parched fields, giving moisture and fertilizer at the same time. Of course the best plan in many instances would be to establish a sewage farm. When purification is desired filter beds could be combined with the farm to care for the sewage when irrigation is not needed, or, if only the removal of the grosser organic matter from the sewage was desired settling tanks could be used, and the sediment, or sludge, be made into a compost for a fertilizer. With the latter plan sewage could be partially purified at a very small expense the year around, and, if tillable land were near, the terrors of a drouth could always be averted over a greater or less area, depending both upon the amount of sewage and land in proximity to each other.

In connection with the above it must be said that Eastern farmers, at least, are very conservative, and through conservatism or neglect might not utilize sewage in either of the ways mentioned. But the ideas advanced are worthy of consideration, especially in the face of the present growth of sewage purification in America.

A FORTIFIED RAILWAY STATION IN INDIA.

The railway system of India extends in some places very near the northern frontier, where there is liability of outbreaks among the border tribes, as well as a possibility of future invasion. Some of the railway stations are, therefore, built as fortified places, to be held by troops, and provisions are made for troop trains and military traffic. We illustrate this week a station of this kind, for the view and particulars of which we are indebted to "Indian Engineering." The station is at Lahore, on the North-western Ry., in the far north, and only about 180 miles from Peshawar, which is the most northern point now reached by railway. It is an important junction of lines on the standard Indian gage of 5 ft. 6 ins., operated by different companies, but forming a system which extends from Lahore north to Peshawar, southwest to Kurrachee, southeast to Calcutta, and southward through the central provinces to Bombay on the west coast and Madras on the east side.



FORTIFIED STATION AT LAHORE, INDIA; NORTHWESTERN RAILWAY.

The illustration represents the main west front of the station, and the north end, with the line to Peshawar. The building is of brick of good quality, and the style is similar to that of some of the other stations on the Northwestern Ry. The interior space, forming the trainshed, is covered by iron trusses in two spans, the inner ends resting upon the walls, and the outer ends upon a line of pointed arches carried by piers. The trusses are covered with corrugated iron roofing. There are four tracks, the two middle tracks being to allow of through or special trains, such as troop trains, passing without interfering with regular train standing at the platforms. There are two main platforms, and on the south, outside the station, are the sidetracks and platforms for embarking and disembarking troops, artillery, etc. The main entrances for carriages and passengers are at the middle of the two sides, and an overhead footbridge crosses the tracks between them. Opening onto the east side platform are the station master's, ticket, telegraph and other offices, as well as the waiting rooms, refreshment rooms and other accommodation for the convenience of passengers. On the west side are the manager's and traffic department offices. Sheltered accommodation for third-class passengers is also provided within the premises, alongside the main entrances.

The general appearance of the building is decidedly military in style, and the defensive arrangements are clearly shown in the cut. They consist of bastions at the angles, with "keeps" or towers above them, which command the several approaches and provide for a flanking defense of the curtains or outside main walls. These walls of the station are loop-hooled for musketry fire over the surrounding neighborhood, and this fire can be further strengthened from the several towers and turrets which overlook and command all surroundings in the immediate vicinity of the station.

These defensive arrangements appear to be all that is necessary to secure the station against an attack with small arms only, or against a sudden rush, and further to provide for the refuge of the railway staff and others in time of danger.

There appears, however, to be no provision whatever for readily closing the end or train approaches; and in this respect the arrangements seem to be deficient, for in the absence of any kind of bullet-proof screens across these openings, those occupying the platforms would be exposed to considerable risks in any determined musketry attack directed against the north or south end of the station. Of course the openings could, in case of emergency, be blocked up with any material ready to hand, but at such a time rapid ingress and egress would become all the more important, and this would be seriously interfered with by resort to such a measure.

Falling shutters, or drawbridges, with proper counterweight arrangements, as suggested by "Indian Engineering," would possibly be suitable for this purpose, and if these were provided and loop-holed for musketry, and a deep broad trench made in front of these openings (which could be spanned by iron girders for train service), then the Lahore station would be fairly well secured against any attack from without, not supported by artillery.

DIFFICULTIES ENCOUNTERED IN DRIVING THE MERSEY TUNNEL.

In our description of the new Vyrnwy water supply for Liverpool, England, in our issue of Aug. 18, the history of the tunnel driven under the Mersey for the passage of the aqueduct was given at length. At the recent meeting of the British Association for the Advancement of Science at Edinburgh Mr. Geo. H. Deacon, the engineer of the Vyrnwy works, read a paper on "Tunneling in Loose Ground," with special reference to the Mersey tunnel, and recounted in some detail the difficulties which were encountered in that work. It must be said that he failed to make clear the reason why he succeeded in the work where two able contracting firms had failed; but he explained very well the great difficulty in tunneling through water-charged material with compressed air. The point on which he lays especial stress, that this difficulty is vastly greater with tunnels of large diameter, is one which every engineer planning tunnel work on this system will do well to bear in mind.

The Mersey tunnel is 800 ft. long, 10 ft. in diameter outside, and was driven at an average depth of 34 ft. below low water. The highest tide level is about 17 ft. above low water mark. The tunnel was driven with a hydraulic shield and lined with cast iron plates. We reprint the substance of Mr. Deacon's paper as follows:

The peculiar difficulties of this work arose from the fact, that while the whole of the material (except certain small lenticular masses of clay) through and beneath which the tunnel was driven was perfectly loose and full of water under direct pressure from above, it constantly varied in the size of its component parts from the finest mud to the coarsest shingle, containing comparatively little sand. In homogeneous mud the operations would have been comparatively easy, but the face of the excavation was quite commonly com-

posed of three totally different materials such as open shingle, sand, and mud, all three under the full and varying pressure of the tidal water above, and all three behaving in a totally different manner; while in some cases a band of hard clay was met with, impervious in itself—but surrounded by water under pressure—never covering the whole face, but sometimes in the bottom, sometimes in the middle, and sometimes in the top.

The following considerations will make the great difficulty thus presented more obvious. In sinking a shaft under air pressure, we free the ground by excavating within and beneath the circular cutting edge attached to the lowest cylinder. That edge being horizontal, we are generally able to maintain the air within the vertical cylinders at such a pressure that the water is kept back at every point of the cutting edge. The cylinders, then, owing to their own or a superimposed weight, sink further. They are from time to time lengthened by adding cylinders at the top; and by freeing the ground below the cutting edge this lining is sunk to the required depth.

In applying this method to tunneling, directly loose materials under water pressure are met with, the much greater difficulty of driving horizontally than of sinking vertically is experienced.

The conditions of equilibrium between the air pressure within the tunnel and the water pressure without the tunnel are obviously different at different levels of the face. Such equilibrium as permits the work to be continued is difficult to attain, and when attained is highly unstable. To meet this difficulty Mr. Greathead has devised many ingenious arrangements, in one of which he excavates by means of hydraulic jets in front of the closed shield or diaphragm (still surrounded by the annular shield overlapping the finished work), and removes the fluid ground by a pipe passing through the shield to the tunnel.

But the great variety of material met with in the Mersey aqueduct tunnel, including large shingle, and in many cases heavy oak timber in good condition, lying prostrate across or parallel with the axis of the tunnel, rendered the use of any such methods impracticable.

In order to understand rightly the nature of the problem, regard must be had to the following considerations:

Imagine a face, with loose material at the end of the finished portion of the tunnel, subject to the pressure, let us say, of 30 ft. of water at the top, and of 40 ft. of water at the bottom of the tunnel, the tunnel being charged with air to balance, let us suppose, the 40 ft. One of two things immediately takes place: Either the air pressure overbalancing the water pressure where at the higher part of the face it has only a head of 30 ft., rushes out in such quantity as to form an upward funnel through the strata, in which case water rushes in below where the pressure in front of the shield is 40 ft., or the air simply displaces the water in the interstices of the porous ground. This action is very rapid. The wet surface of the face seems instantly to dry up, in fact, so complete and rapid is the drying that in a few seconds it is difficult to imagine that the face has been wet within the last twenty-four hours. But with this change the whole condition of equilibrium is altered. The head of water at the face is partly displaced by a head of air—a great bubble—in the interstices of the ground, having the form of a balloon, continuously supplied with air from the end of the tunnel which it dissipates from its upper surface into countless smaller bubbles, so that the total pressure at the face is suddenly much diminished. The flow of air through the interstices of the material continues and only attains a normal rate—equal to the supply of air to the tunnel—when the pressure in the tunnel has so far fallen as to exactly balance the static head of air and water above the fall, plus the friction of the moving air in the interstices of the ground. This state of things lasts, and the ground continues to be held back in a visibly dry condition, until, by a change of resistance of the passage of the air upward through the ground, the equilibrium is again disturbed. With every rise or fall of the tide such a change occurs, and in the case of the Vyrnwy aqueduct tunnel under the Mersey, it took place in virtue of a change of the strata at every few yards driven. In a vertical shaft, such changes are comparatively unimportant, but in a horizontal tunnel the case is clearly very different.

Even in ground of uniform porosity it is generally difficult to keep the water back at the lower edge of the shield, and obviously this must be so, because at this point the water, when quiescent, has nearly the full hydrostatic head, notwithstanding the great bubble of moving air in the interstices above it. It is therefore generally necessary to permit a small inflow of water to take place at this point, and thus to allow the friction of the water through the ground to bring the pressure in the ground at the bottom of the shield down to the lower pressure in the tunnel required to balance the pressure higher up the face; but, if the flow at this lower point is allowed to become sufficient to disturb the ground, the resistance to that flow is reduced, the equilibrium is upset, the great bubble is displaced and moved by the moving sand and water below, and an inrush instantly occurs.

So much for strata of uniform porosity. But, as already stated the Vyrnwy aqueduct tunnel had to be driven throught rapidly varying strata. From time to time, without any warning, the resistance to the inward passage of water at the lower edge of the shield suddenly fell. Almost instantly the great bubble of air was lifted bodily, and the face of dry ground became a surging current of liquid mud. Occasionally the same change began at a higher level of the face, owing to the resistance of a higher stratum to the passage of water rapidly falling. But, however it arose, the result was instant upsetting of the equilibrium, and a dangerous rush of liquid ground into the tunnel.

The shield employed by the second contractor for driving the Vyrnwy aqueduct tunnel was of the Barlow form—a cylinder with its forward end carrying a cutting edge, and its backward end overlapping the finished work all round, and a diaphragm across it provided with many covered openings through which the excavation was performed. But the construction of the shield was much too light, and when the work was taken over by the corporation, the cutting edge had collapsed and bent inward for about one-fourth of the circumference to an extent in one place of about 15 ins. Moreover, there was a longitudinal crack near the bottom of the annular shield, extending from the tail nearly to the diaphragm.

As usual in such cases, it was at this stage commonly asserted that the work was impracticable, and would never be finished. It had most seriously delayed the completion of the Vyrnwy aqueduct, but even at this late period the necessity for obtaining an Act of Parliament to deviate the line of aqueduct was in some quarters seriously contemplated. Familiarity with the subaqueous workings had, however, only served to confirm the author's opinion of the feasibility of the undertaking, which at an earlier stage he had offered to carry out without the intervention of a contractor, and this course was now decided upon.

To have to conduct the work with a shield insufficiently strong, and in such condition, was not a satisfactory beginning. The author had no doubt whatever that with a properly designed shield it could have been rapidly performed. He was not certain that it could be done with the existing shield; but all things considered, and rather than attempt to replace it in the disturbed ground in which it then lay, it was thought better to repair and strengthen the existing shield, and at least to make an effort to proceed with it. The repairing and strengthening of the cutting edge was successfully performed, and 4½ months after the commencement of the first contractor's work the tunnel was recommenced. The most effective method was found to be to remove the lower part of the diaphragm, to regulate the air pressure as nicely as possible at such point below the hydrostatic pressure that while—so long as the shield was kept moving—it was generally insufficient to blow a funnel from the upper edge of the shield to the river above, it was just sufficient to prevent an inflow at the lower edge of the shield sufficiently rapid to carry the ground with it.

At intervals round the cutting edge steel teeth were added before the work was recommenced, and the author is disposed to think that they were of great use in penetrating shingle. Several feet behind the main diaphragm was placed a partition projecting upward to a level above that of the under side of the remaining portion of the main diaphragm. This proved to be exceedingly useful when a blow of sand and water occurred. It did not materially hinder access to or from the front of the shield, while there can be no doubt that when a blow took place it choked itself more readily than if such an obstruction had not existed. The author was indebted to Sir Benjamin Baker for suggesting this device and that of the teeth.

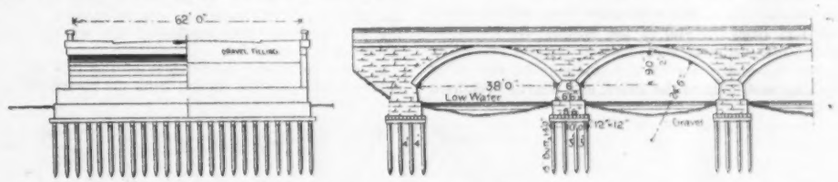
During the latter part of the progress the longitudinal crack already mentioned near the bottom of the shield became worse, another crack worked from it circumferentially behind the diaphragm, and the plates of that portion turned down like a ploughshare from their proper position. This caused a delay of 12 days, included in the 4½ months. The ground at the time was as bad as it could be, but the piece 6½ ft. long and 9 ft. wide was successfully cut away and replaced in situ. The portion cut away could not be removed, but was left behind by the advancing shield when the work was recommenced.

In conclusion, the author desires to draw attention to the fact that the condition of unstable equilibrium to which he refers, and which creates most of the difficulties in shield and pneumatic tunneling, rapidly increases with the diameter of the tunnel. He has no doubt whatever that a shield may be constructed in any particular case to meet all the contingencies that can arise; but it is from works like the Vyrnwy aqueduct tunnel under the Mersey, in which the means of meeting difficulties are not sufficiently provided, and where success is nevertheless attained, that the most valuable lessons are to be learnt.

THE MT. VERNON VIADUCT.

We are indebted to Mr. C. E. Fowler for the accompanying drawings and description of a new stone arch viaduct now under construction to carry Main St., Mt. Vernon, O., across the Kokosing River, just outside the corporation line. Before deciding on the type of structure, prices were obtained on an iron structure about two-thirds as wide, and it was found that it could be built for about $18,000, while the accepted stone design will cost about $30,000. The County Commissioners decided to build a monumental structure.

There are five arches of 380 ft. span, 9 ft. rise and



CROSS SECTION AND ELEVATION OF STONE VIADUCT, MT. VERNON, O.

24 ft. 6 ins. radius, extending the full width of the street, 60 ft. The foundations are on piling, 15 ins. at butt, driven about 14 ft. into gravel. There are 92 piles under each abutment and 100 under each pier, of such wood as was available, gum, oak, etc.

On top of the piles, caps 12 × 12 ins. × 10 ft. were fastened with two 2-in. drift bolts. The space between the caps was filled up level with grout, and covered with 12 × 12 in. timbers, laid lengthwise, and drift-bolted close together. On this platform the masonry was laid. The timbers are about 6½ ft. below low water, and are lower than the old timbers, which were found to be perfectly sound after 40 years' use. The stone is Holmes Co. sandstone, and is laid in Louisville cement mortar, 11 of

Centering Used in Constructing Mt. Vernon Viaduct.

cement and 20 of sand. All voids are filled with spawls laid in mortar, except in the springing course, where "hard heads" are used instead of spawls. The centering is made of braced rafters, placed 4 ft. 3 ins. c. to c., with ribs of 12 × 1 in. segments. Three thicknesses are spiked together, and the ribs are spaced 2 ft. 1½ ins. c. to c.

The approach on the town side will have a slight grade, and will be about 55 ft. in length, while on the other it is about 25 ft. long. The filling will be of gravel; the sidewalks will be laid with flagstones 11 ft. in width. The roadway will be paved with the same kind of blocks as the street.

The piling costs from 8 to 10 cts. per lin. ft., delivered, the stone about $3 per cu. yd. on the cars at the site. The contract price for the masonry is $6.50 per cu. yd., and the total cost of the structure will be about $30,000.

Mr. A. Cassil, City Engineer of Mt. Vernon, has charge of the work, and it is expected that the structure will be completed in October. The contractors for the entire structure are T. B. Townsend & Co., of Zanesville, O.

THE SAN MIGUEL BRIDGE FAILURE.

We are indebted to Mr. F. Meredith Jones, of Las Vegas, N. Mex., for the accompanying view and details of the failure of the Atchison, Topeka & Santa Fe R. R. bridge across the Pecos River, in San Miguel Co., N. Mex., on June 30. The bridge is a single span Pratt truss, 130 ft. long, resting on masonry abutments, and was erected in 1881, replacing a pile trestle which had carried the traffic for three years.

A few hours before the failure an unusually heavy rain storm had occurred, raising the water in the river to within 3 ft. of the floor beams, or about 11 ft. above its normal height. At the bridge site the river turns a sharp angle, forming an eddy. The failure was caused by the undermining of the abutment by the scouring action of the current, formed by this eddy, allowing it to careen over as shown in the cut. As soon as this movement became sufficient to allow the end posts to drop behind the abutment the weight of the bridge was thrown onto the floor beams, which tore loose and were raised, and the chord bars of the end panel which were badly bent. When settlement ceased the abutment was 1.6 ft. out of line up stream, and 10 ft. out of line across the stream. The bridge floor had risen at the end, but was 2.8 ft. below grade at the first panel point.

A simple and efficient plan was adopted to preserve the bridge in case of any further settlement of the abutment. Three rows of piles were driven about five feet from the end of the bridge. Across these piles 30-ft. stringers were placed, one end projecting under the end posts of the bridge, and the other running back toward the shore, and heavily weighted

UNDERMINING OF ABUTMENT OF BRIDGE OVER PECOS RIVER, SAN MIGUEL CO., N. MEX.

with timber, stone and a loaded car. A cantilever was thus formed resting on the piles as a pier, one arm of which supported the bridge, the other being anchored by the loaded car and stones. To support the floor beams at the first panel point two timbers were laid lengthwise of the bridge, one end resting on the end of the cantilever arm and the other on the bridge floor, near the second panel point, and chains passed around the timbers and floor girders. The position of these timbers is clearly shown in the cut.

Immediately after the failure a temporary trestle was built around the old bridge to provide for the traffic until repairs could be made. The soundings taken after the failure, which showed a smooth, flat bed rock 8 ft. below low water, or 26 ft. below rail grade, would seem to show someone at fault in the construction of the foundations. As it is hardly possible that the abutment would be constructed on a soft material liable to be scoured out by the water, especially at a point where currents would be probable on account of the formation of the river banks, to save the expense of a few square yards of masonry, and a light coffer-dam at the most, it would seem that the neglect to secure a firm foundation must be attributed to carelessness.

SEWAGE PRECIPITATION WORKS AND REFUSE DESTRUCTOR AT SOUTHAMPTON, ENGLAND.

The following is an abstract of a paper by Mr. Wm. B. G. Bennett, Borough Engineer and Surveyor, read at the meeting of the Institution of Mechanical Engineers at Portsmouth, in July, as noted in our issue of Aug. 18. The Shone ejector system was described in our issue of Aug. 4:

Early in 1885 the corporation of Southampton considered it expedient to introduce a more efficient system for the collection and disposal of house refuse, and about the same time they found it desirable also to clarify by precipitation the sewage of a particular district of the town, which was being discharged in its crude state direct into Southampton Water at the town quay. Having been instructed to devise a scheme for accomplishing these objects, the author proposed the adoption of Messrs. Manlove, Alliott, Fryer & Co.'s refuse destructor for destroying the ashbin contents and garbage of the town; and also that the sewage sludge should be transmitted to the destructor from the two existing reservoirs in which it was deposited in the process of clarification. These reservoirs are each 100 ft. long and 60 ft. wide, and at the lowest end 10 ft. deep. Formerly the sewage of a district of the town, amounting to 500,000 gallons in 24 hours, from a population of about 13,000, for the most part flowed by gravitation into these reservoirs, whence it was discharged into the tideway at low water, while a small portion, coming from a low-level sewer, passed direct into the tideway through iron pipes laid under the reservoirs. The reservoirs act alternately, one being left still for precipitation of the sewage while the other is being filled.

In order to render independent of the tide the discharge to the clarified effluent from the reservoirs, and to raise the low-level sewage into the reservoirs for treatment with the rest, two Shone pneumatic ejectors were erected (Eng. News, Aug. 4), both of which are worked by power obtained from the destructor; the smaller, of 360 gallons capacity, is placed below the invert of the low-level sewer, and serves for transmitting the sludge from the reservoirs to the destructor, as well as for raising the low-level sewage; and the larger, of 700 gallons capacity, is placed in the east reservoir, for discharging the clarified effluent into the Southampton Water. There is also a third ejector of 360 gallons capacity, which deals with the sewage of another district of the town near the destructor works, and is likewise worked by power obtained from the destructor. With an air pressure of 12 lbs. per sq. in. it raises the sewage about 18 ft. from a low-level sewer to a higher one. This ejector was formerly worked by an independent steam engine, costing for coal about $600 per annum, which is now saved since the adoption of the destructor.

The sewage gravitates from the sewers through an inlet pipe into the injector, and gradually rises therein until it reaches the underside of the bell. The air at atmospheric pressure inside this bell is thus inclosed, and the sewage continuing to rise outside above the rim of the bell compresses the inclosed air sufficiently to lift the bell, the spindle of which then opens the compressed air admission valve. The compressed air thus automatically admitted into the ejector presses on the surface of the sewage, driving the whole of the contents before it through the bell-mouthed opening at the bottom and through the outlet pipe into the iron rising main, or into the high-level gravitating sewer, as the case may be. The sewage can escape from the ejector by the outlet pipe only; because the instant the air pressure is admitted upon the surface of the sewage, the non-return flap-valve on the inlet pipe falls on its seat, and prevents the sewage from escaping in that direction. As the sewage flows out of the ejector, its level therein falls to that of the cup; and still continuing to lower, it leaves the cup full, until the weight of the stuff in the portion of cup thus exposed and unsupported by the surrounding sewage is sufficient to pull down the bell and spindle, thereby shutting off the admission of compressed air to the ejector. The compressed air remaining within the ejector then exhausts through an air escape valve in the top, which is opened by the fall of the cup and spindle; and the sewage outlet non-return flap-valve falls on its seat, retaining the sewage in the rising main. The sewage then flows once more into the ejector through the inlet, driving the free air before it through the air escape valve as the sewage rises; and so the action goes on as long as there is sewage to flow. The position of the bell and cup floats is so adjusted that the compressed air is not admitted until the ejector is full of sewage; and is not allowed to exhaust until the ejector is emptied down to the discharge level.

In each reservoir there is a floating sewage inlet, consisting of a pipe hinged to the larger ejector, and shackled to a buoy; the latter causes the free end of the pipe to rise and fall with the water-level, keeping its mouth, which is covered with perforated plate, a few inches below the surface of the liquid. In order to prevent the entrance of any floating solid matter. Directly the clarification by precipitation has been effected to a certain depth, a valve is opened, admitting the liquid into the ejector, whence it is at once discharged into the tideway. A supplementary sewage outlet is also provided in each reservoir for discharging the liquid by gravitation when the tide is low enough. When the whole of the liquid has thus been drawn off, the buoy, resting now upon the floor of the reservoir, keeps the mouth of the inlet pipe high enough to prevent the entrance of any sludge into the larger ejector; and the sludge is then admitted into the smaller ejector by opening a valve, and is transmitted by air pressure through a line of 4-in. cast iron pipes, nearly a mile in length, to the destructor. An air pressure of 40 lbs. per sq. in. is required for working the sludge ejector, and of 10 lbs. for the effluent ejector.

Ferrozone supplied by the International Water & Sewage Purification Co. is used for precipitating the sludge; it is mixed with just enough clean water to make the whole into a stiff paste, which is led through a shoot into a box with perforated sides, placed in the sewer. The sewage flowing past washes the ferrozone gradually out of the box, and is thoroughly mixed with it by the time it discharges into the reservoirs at a manhole 150 ft. from the box. A small stream of water falling upon the ferrozone prevents it from consolidating. The box is filled three times in 24 hours; and this method of dosing the manure has proved quite efficient and satisfactory.

On arriving at the destructor the sludge is delivered into a cell, from which it is drawn as required through a valve-pipe; and after mixture with road sweepings or sorted house refuse it is turned out as a good manure, which from the commencement has all been readily bought up by agriculturists at 4s cts. per load delivered at the works. On an average 67 cartloads of ashbin contents are daily collected and disposed of, the ascertained weight of the load in each cart averaging about 1,900 lbs. The road sweepings are never burnt, but to keep pace with the demand, the sludge is run into bays made of the road sweepings, and is also filled in with them. The quantity of road sweepings thus utilized amounts in 24 hours to about eight tons. Arrangements were provided at first for burning the sludge, for which purpose it was discharged into a tank on the floor of the destructor, and drawn out through ports in the front, opposite the feed openings of the firing chambers, where its moisture was absorbed by the ashbin contents, which were backed up against the ports with this object, and the mixture was then raked into the fires. Large quantities of sludge have been thus destroyed, but the process has been discontinued, owing to the ready sale of sludge when prepared for manure.

The refuse destructor has six chambers or furnaces, each capable of burning eight to eleven tons of garbage per day. The products of combustion pass through a 30 HP. multitubular steel boiler in the main flue, into a furnace shaft, which is of circular brickwork, 160 ft. in height from the ground line, 6 ft. inside diameter at top, and 7 ft. at bottom. The shaft is constructed upon a pedestal 14½ ft. square, and 24 ft. high, of brickwork 3 ft. thick, and thence upward in four sec-

tions, of which the first is 27 ins. thick and 30 ft. high, the second 22½ ins. thick and 30 ft. high, the third 18 ins. thick and 34 ft. high, and the fourth 14 ins. thick and 38 ft. high. The first 30 ft. in height is lined with firebrick, and behind the lining is a cavity 4½ ins. wide, which is ventilated by apertures to the cutside of the shaft. The foundation is loamy clay, upon which is laid a bed of concrete 30 ft. square and 10 ft. thick. The footings commence at 23 ft. 2 ins. square, and step off in regular courses upward to 15 ft. square at a height of 6 ft. The concrete was filled in continuously until completion. The pedestal was then run up and allowed to remain for nearly three months during the winter; after which the work was proceeded with until completion, occupying about six months more. The cap is white brick in cement, with a string course about 20 ft. below the top. Foot irons are built inside in a winding lead up to the top. The shaft is provided with a copper tape lightning conductor, with iron rod and crowsfoot, 7 ft. from the cap; the tape is about 215 ft. long, the bottom end being carried into a well. In August, 1888, the shaft was damaged by lightning, but was easily repaired, owing to the provision of the footirons built inside it. At that time the shaft was plumbed and was found to be quite vertical. The fires were only damped during the repairs, which occupied about eight days. With the exception of this interval they have been constantly burning for nearly six years. The repairs have been almost nil. There is also a by-pass, for enabling the burning process to be continued when the boiler is not required or during cleaning and repairs. No obnoxious fumes from the combustion have been perceived.

The steam generated in the boiler is employed for driving a pair of engines of 31½ I. HP., which compress air into two large receivers, whence it passes in a 5-in. main to the town quay, where it is automatically supplied to the ejectors when required for working them. The air also serves for driving the precipitated sludge through the main from the reservoirs to the destructor; for which purpose the air is led by a pipe from the receiver at Chapel wharf to the head of the main at the town quay. A 6 HP. engine, used in connection with the machinery for the preparation of fodder for 40 horses at the corporation stables, is also driven by steam from the same boiler.

All obnoxious matters are collected throughout the borough in covered iron tumbler carts of 2 cu. yds. capacity, which go up the inclined roadway approach to the destructor, and discharge their contents into the firing chambers. The road sweepings are frequently discharged into a hopper over an incorporator driven by a small engine, and are mixed with the sludge as required; this is generally done in wet weather. The residue from the continuous day and night combustion consists of about 20% of good hard clinkers and sharp fine ashes. The clinkers are used for the foundation of roadways and the manufacture of paving slabs, which have already been used in paving several footpaths of the town and the new public baths at a cost of 60 cts. per sq. yd. The fine ashes are also employed for making mortar, with which the stables and swimming baths have been erected, and for many other purposes. The mortar is also sold to builders at $1.80 per cu. yd.

The waste heat from the destructor is utilized for producing electricity. The air-compressing engines drive a dynamo of 150 volts. At the present time the works are lighted with two arc lamps of 3,000 c.p. each and 12 incandescent lamps of 16 c.p. each; and four streets in the vicinity of the works have been lighted experimentally for the information of the corporation, who, from the successful results obtained, resolved to extend the installation to the municipal offices, a town clock, the Hartley Institution, and the Town Hall. For this purpose it was proposed to place accumulators in the basement of the municipal building and charge them through a cable from the works. Circumstances having led to the abandonment of the street lighting, the public became financially the losers, and a private company is now supplying consumers.

The destructor is also employed in lending a helping hand to a neighboring authority, by supplying to the Local Board of Shirley and Freemantle, about 2½ miles from the works, sufficient compressed air to work ejectors which they have erected in connection with the disposal of their precipitated sewage sludge from a population of 15,000. The compressed air is conveyed through a 4-in. main from the destructor works to their precipitation reservoirs, thus saving them the cost of a pumping station, and bringing to the corporation a return of $1,000 a year, which is received for the compressed air supply. Thus the destructor works are now dealing with the sludge of nearly 30,000 inhabitants.

The initial cost of the complete destructor, including engine-house, inclined roadway, chimney-shaft, boiler, and ironwork, was $18,615; and the sewage disposal works on the Town Quay cost about $15,000. This is exclusive of the Shirley and Freemantle works, which consit of three reservoirs very similar in construction to those at the Town Quay.

The annual expense for burning refuse is as follows:

Two stokers, one day and one night, at $6.25 per week	$650.00
Two feeders, one day and one night, at $5.83 per week	606.32
Total per annum	$1,256.32

The quantity of refuse burnt per day of 24 hours is a little over 50 tons, so that the cost of burning is about 7 cts. per ton. The minimum quantity burnt per day of 24 hours is about 25 tons, which has been sufficient to maintain steam for the engines of 31½ I. HP. This is equivalent to 1,792 lbs. of refuse per I. HP. for 24 hours, or 75 lbs. of refuse per I. HP. per hour.

The annual expenditure for the sewage clarification and disposal is as follows:

Precipitating material for 365 days, averaging about $1.25 per day, say	$450
Engine-driver, and laborers at reservoirs	640
Two men at wharf, mixing manure	520
Total per annum	$1,610

The amount realized from the sale of manure and for the supply of compressed air during last year, 1891, was $3,000. The products from the destructor, including concrete slabs, clinkers used for concrete foundations, and fine ashes for mortar and for foundations of footwalks, represent about $1,500. To these may also be added the saving of the coal which was required for working the engines previously to the establishment of the destructor.

THE DRIVEN WELL SYSTEM OF SCHUYLER, NEB.

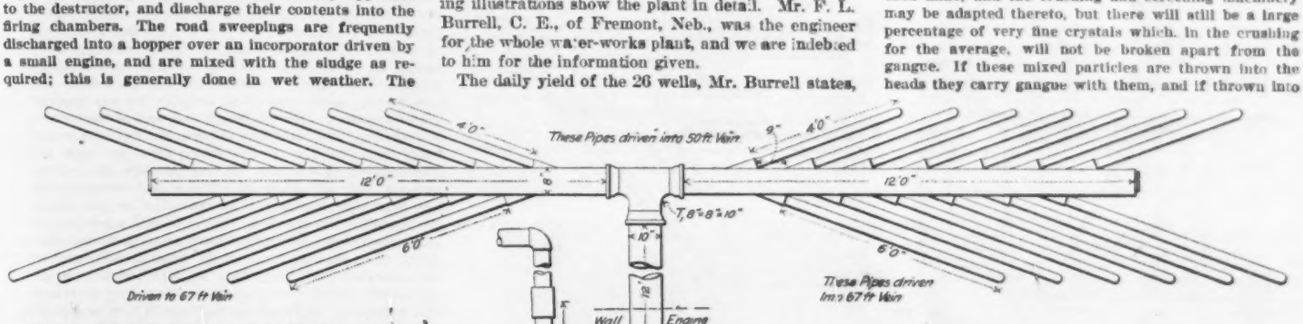
A system of 26 driven wells was put in operation at Schuyler, Neb., on Feb. 9, 1892. The accompanying illustrations show the plant in detail. Mr. F. L. Burrell, C. E., of Fremont, Neb., was the engineer for the whole water-works plant, and we are indebted to him for the information given.

The daily yield of the 26 wells, Mr. Burrell states, is 700,000 gallons. The yield would have been greater, but the area was so limited that the wells had to be driven too close together. As will be seen, the points on one side of the gathering main were driven to a 50-ft. and on the other side to a 67-ft. vein. The wells driven in the 50-ft. vein pierced material approximately as follows:

Black loam	5 ft.
Sand and gravel containing water	16 ft.
Hard blue clay	10 ft.
Dry sand	2 ft.
Hard blue clay	7 ft.
Saturated sand and gravel	10 ft.

The points in the 67-ft. vein pierced another stratum of hard blue clay, about 14 ft. thick.

Mr. Burrell makes the readily understood statement that driven wells may often be successfully sunk in sandy soils, but in clay soils, where the water does not flow freely, the open well gives the best results.



DRIVEN WELL PLANT AT SCHUYLER, NEB.; F. L. Burrell, Engineer.

THE CHASE MAGNETIC ORE-SEPARATOR.

The magnetic concentration of iron ore, or the separation of the magnetic particles from the crushed ore, is a process of growing importance in the production of iron, and in our issue of Oct. 17, 1891, we discussed this matter editorially, and printed two papers read before the American Institute of Mining Engineers, and bearing upon this subject. Some notes on the same subject were also given in our issue of Feb. 27. The granulation of iron ore for treatment by this process was the subject of a paper read by Mr. Axel Sahlin, at the meeting of the Institute in June last (Eng. News, July 14), and as noted in the report of the meeting in our issue of July 7, a magnetic separator, the invention of Mr. Harvey S. Chase, of the International Ore Separator Co., was exhibited in operation. The following is an abstract of a paper read by Mr. Chase, describing this machine:

After considerable experience in connection with the magnetic iron ores at the South, especially in the Cranberry district western North Carolina and east Tennessee, the writer was led into a thorough investigation of the magnetic separation of iron ores, and from this investigation, has gradually been developed a separating machine which it is the purpose of this paper to explain.

Numerous United States patents have been issued upon machines for magnetic separation. Since the original patents date back to 1849, it is not possible to-day to establish broad claims upon the principles of electromagnets as applied in such machines. Among these inventions there are certain types of separators which have very marked practical advantages over the others; and these successful machines, while varying radically from each other in their proportions and arrangements, are all based upon a principle originally explained in a patent which was granted in 1870, and which has now expired by limitation.

The problem of practically separating iron ores, as found in the mines, is very different from the separation of purely magnetic substance from a purely non-magnetic one, since the crystals of magnetite, scattered through ore-bearing rock, and sometimes collected in masses, are of very different sizes. The average size of the particles may be definitely ascertained for each mine, and the crushing and screening machinery may be adapted thereto, but there will still be a large percentage of very fine crystals which, in the crushing for the average, will not be broken apart from the gangue. If these mixed particles are thrown into the heads they carry gangue with them, and if thrown into the tails they occasion a loss of iron ore. There are two methods for preventing such loss. One is, to crush all the material to the size of the finest particles, which means, of course, a large crushing plant, heavy wear and tear, and excessive cost for repairs, and the production of only a very fine grained concentrate which blast furnace managers, to say the least, do not ardently desire. The other, and only practicable method, is to crush at first to a comparatively coarse size, determined by the character of the material, and to separate immediately upon a machine which has a power of selection, and which will throw off a first grade of tails, containing practically no magnetite, then a second tails or middlings, with iron in the mixed particles, then a third (and, if necessary, a fourth, etc.) division, and, finally, a practically pure magnetite as heads. The first tails go to the dump, the heads, comparatively coarse, are sent at once to the bins or cars, and the second and third or other tails, which may amount, perhaps, to one-fourth of the crude material, are treated on a second separator, and such portions of them as may require it are crushed sufficiently fine to break the magnetite from the gangue. The fine crushing of three-fourths of the product is thus saved, and the cost and wear are correspondingly reduced, while the concentrates contain mainly coarse particles. These facts have been appreciated for many years by those skilled in the art; but the mechanical and electrical difficulties in the designing of practical machines were deemed by many to be insurmountable. There are, however, now on the market, as already remarked, a number of forms of separators which act on this principle, and

are excellent machines, each protected by special patents.

The machine which is the subject of this paper is one of these. In designing it we have endeavored to keep in mind the essential requirements for machinery subject to rough usage, viz.: (in addition to efficiency and economy of operation) durability, simplicity of design, and convenience for replacing quickly by ordinary unskilled labor any disabled parts, considerations which apply as well to magnetic separators as to other machinery connected with mining.

This machine has grown out of the original Lovett-Finney magnetic separator, which has been running successfully at Weldon, N. J., for 18 months or more. We have retained the features of simplicity and low cost for repairs which distinguished that apparatus, but have changed the form and the electrical arrangement and have added other magnetic parts which essentially modify the action of the separator and the character of its products.

The present form of the magnetic wheel is a solid soft iron roll of small diameter (4 ins. or less), and any desired length (usually 3 ft.), in which two helical grooves of about 1 sq. in. section are cut. In these are wound coils of continuous copper wire or ribbon. There being two spiral grooves (constituting, in fact, simply a double-threaded screw), the wire carries the electric current in each groove in the opposite direction from that of the current in the adjoining groove, so that a magnetic circuit it set up which converts the screw thread into continuous helical poles of opposite polarity, and forms, with a minimum amount of iron, copper, and cost of manufacture, a magnet of extraordinary strength, with a continuous field of magnetic force all over its circumference. A thin, drawn-brass tube is slipped over this roll, protecting it from injury, without impairing its properties as a magnetic wheel, equally efficient per square inch of surface whatever the length of the roll may be.

In the Chase separator, as shown in Figs. 1 and 2, are three of these magnetic rolls, A, B and C, Fig. 1. The function of the first roll is to separate a wholly non-magnetic grade of tails from the remainder of the material treated. As the crude material is fed upon a belt, which approaches the wheel horizontally, the necessary consequence is, that every particle of magnetic oxide of iron comes immediately within the scope of the magnetic field, and cannot escape until carried by the rotation of the roll around to its under side, while the non-magnetic tails fly off tangentially.

The pure magnetite, the mixed particles, and a considerable amount of non-magnetic dust, all cling together to the belt against the under side of the roll, and are passed on by the movement of the belt to the first of a series of horizontal magnetic poles. These are "consequent poles," developed by winding a soft iron yoke alternately in opposite directions, and inserting between these windings soft iron bars to form the poles. A tumbling motion is immediately set up in the mass; the middlings drop quickly into their receptacle; the fine dust continues further, but falls also into its receptacle, while the pure magnetite passes along under all the poles and is delivered by the last of these to the second magnetic wheel, B, which whisks the magnetic particles around the sharp corner, freeing them from the last grains of dust by this movement, together with the action of a blast of air of water from the pipe P. The second wheel, B, delivers the magnetite to the third or picker wheel, C, over which runs the second belt, which carries the magnetite to any desired point. The other letters indicate the following parts: D, driving pulley; E, tightener pulley; F, non-magnetic rolls, delivering heads; H, feed hopper and feed wheel; O, overflow.

The separator is simple in its construction and cheap to build. Its wearing parts consist of the bearings for the shafts, and the cheap cotton duck belt, which receives all the wear from the ore, enduring, by reason of its softness, as wax does before the sand blast, the blows which would cut rapidly into a harder and stiffer material. These belts have been in use for 18 months upon the separator at the Weldon mine, in New Jersey, and have demonstrated their durability under these conditions.

The merit of this design is mainly in the comparatively small rolls and the short distance between the magnetic poles, which are never increased, however wide, and correspondingly capacious the machine may be. The winding of the magnetic rolls in double spiral with continuous spiral poles gives a magnetic field of equal efficiency whatever the length or diameter of the rolls, and the winding of the intermediate magnet is such that it is exactly as efficient per square inch of surface whatever the width of the machine may be. There is, therefore, no limit to the width of the machines, except such as may be set by mechanical considerations.

The length of the separator depends entirely upon the length of the intermediate magnet, which decides the number of "tumbles" of the stuff, and thereby the quality of the concentrates. This may vary with different ores and degrees of fineness of crushing.

Very interesting facts in connection with electro-magnets of these irregular forms have been brought out in our experiments; and as the matter is one of considerable importance, involving the substitution of another unit of measurement in place of that now in general theoretical use, I feel justified in going over ground already familiar to many. In nearly all electrical winding to-day the cores of soft iron are of circular section, and the wire is in continuous turns about the core, so that the term "ampere-turns" has come to be accepted as a reliable measure of the magneto-motive force, and hence of the number of lines of force passing through the core. The design of irregular forms of magnets like the H-section and spirally-wound wheel, already described, has compelled us to look for another basis of measurement, as "ampere-turn" is not applicable to the spiral winding; and we have thus been led to see that too much emphasis has been laid upon the "ampere-turn" in theoretical laws and formulae, and that the term "turn" has received, in this connection, a special significance which it should by no means have. There is absolutely no advantage in a completed circle over the same length of straight wire for the creation of magneto-motive force, and therefore a "turn" merely represents a certain length of wire. The point of the explanation is, that for "ampere-turn" the terms "ampere-inch" and "ampere-centimeter" should be substituted, inasmuch as the latter terms are appplicable to all forms of magnet coils, while the former is only applicable to a certain special case.

The main commercial objects of magnetic separation are, first, the diminution of the amount of earthy gangue, with a consequent increase of the percentage of metallic iron in the product, and, second, the incidental elimination of phosphorus (usually present in apatite), and often of sulphur or titanium. A crude ore, carrying about 30% of iron, and reasonably coarse in structure, can be concentrated to 66 or 68% very readily. The loss of iron as magnetic oxide in the tails, in practical every-day running, will not exceed 3 to 4%, while the total loss in the tails will depend upon the amount of iron present in the crude material in a non-magnetic state, such as the sesquioxide, silicates, and sulphides, though each of these may be at times somewhat magnetic, the sulphides especially, one variety of which, pyrrhotite, is notoriously so.

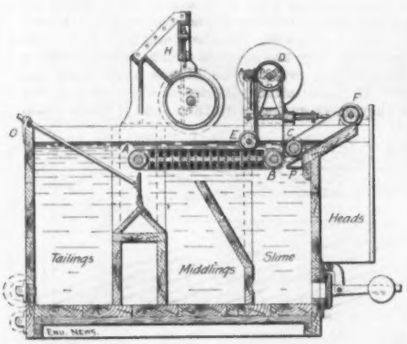


Fig. 1. Longitudinal Section.

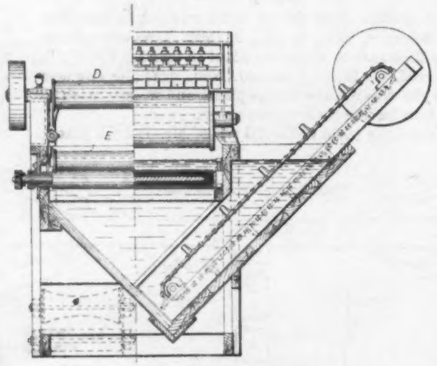


Fig. 2. Cross Section.

CHASE MAGNETIC ORE SEPARATOR.

There is a general protest from all magnetic-separating experts against the usual method of judging results by percentages of metallic iron. Every one familiar with the subject through actual practice appreciates the misleading nature of this test in comparing results from different separators working on different ores. Especially is this true with regard to the loss in tails. Some rich ores leave, after separation, a very small amount of tails, so that a relatively minute quantity of iron lost may yet make a large percentage in the scanty tailings, while low-grade crude ore of the same mineralogical character and physical texture may, on account of the greater bulk of the tails, present, apparently, a much better showing in percentage of loss. The only proper way, in such comparisons, is to determine the percentage of magnetic oxide saved, and the percentage lost, out of the original amount in the crude ore. This gives a basis for comparison, as to the efficiency of the machinery and its adjustment, which is not misleading.

After all is said, it still rests with the crushing and granulating part of the plant whether there be a financial success or failure. In nearly every case the crushing costs from four to five times as much as the magnetic separation, and requires, moreover, the greater part of the original cost of installation. It is for this reason that we believe that a separator, which will relieve the crushing-plant of a considerable portion of its work, must be a factor of great importance in the problem of magnetic separation, permitting the use of a smaller plant for a given aggregate product, and greatly lessening both the initial outlay and the cost of current repairs, and which accomplishes this result by its ability to divide the coarsely-crushed mass of crude material into various distinct grades, each of which may be specially treated afterward, according to its needs.

Another important point in favor of this machine is its adaptability to wet separation, by which I mean, to the treatment not of partially wet or damp material, but of material which is acted upon by the alternating-poles when wholly below the surface of water. The action in this case is the same as in air, with the additional advantages of the solving and washing effects of the water, as well as the diminution of gravity of the particles, which fall more slowly from the belt. For separating very dusty ores, the use of water is indeed essential, especially when the fine dust is, in considerable part, apatite, which is liable to cling to the magnetite and, in the dry process, to be carried into the heads in spite of strong air-blasts. Under water, there is no tendency on the part of any earthy minerals to cling to the magnetite; all the dust is washed off immediately, and the heads come out in a thoroughly cleansed condition, carrying 2 or 3 % more iron, and considerably less phosphorus, than by the dry process.

The separator here described can be operated either wet or dry, without other change (for the latter purpose) than draining off the water from the tank and attaching an exhaust-fan. When specially constructed, however, for dry work, the frame and arrangements are somewhat modified. As remarked at the outset, the machine has grown up naturally and gradually out of a very careful study of the whole subject, and especially after examination, on the ground, of nearly all the notable separating-plants in this country, an investigation which convinced the writer that there was still abundant "room at the top" for a new and practical separator. Its success is largely due to the co-operation of Mr. Axel Sahlin, the engineer of the International Ore-Separating Co., to whose ability and experience the credit should be chiefly ascribed for the mechanical compactness and simplicity of the large machines.

THE PRIESTMAN PETROLEUM ENGINE.

The petroleum engine manufactured and introduced in this country by the well known firm of Priestman Bros., London, manufacturers of dredges, hoisting engines, etc., was described and illustrated in our issue of Nov. 17, 1888, and we give below some particulars taken from a paper by Dr. Coleman Sellers, consulting engineer for the American branch of the firm, which was written as a discussion of a paper on "Petroleum Engines" read before the Institution of Civil Engineers, England, by Prof. W. C. Unwin.

Mr. Henry G. Morris, formerly a member of the firm of Morris, Tasker & Co., called the firm's attention to what Prof John Sweet had accomplished in high-speed engines in his construction of the straight line engine. A visit was paid to Prof. Sweet, at Syracuse, when that able engineer, being fully informed as to the merits of the Priestman engine, was quite ready to aid in the introduction to the United States and with commendable liberality he offered his valuable advice and arranged to assist in the production of the first engines of this design as far as his special machinery could be spared from his own work. It thus came

about that a type of engine already well adapted to high speeds came to be applied. The Priestman engine, designed on the straight line principle, with all the working parts accessible, and made with a view of great endurance, was built and tried, after which the firm of Priestman & Co. saw that it would be wise to give the Americans what pleased them the best, and decided to depart from their own model in this branch establishment. When I was called to give advice as consulting engineer, I recognized the correctness of their judgment and heartily approved of the course they were about pursuing.

The American engine has two flywheels, the disk hubs of which carry the crank-pin, both wheels being between the bearings of the engine frame. These flywheels are not used for the transmission of motion by means of a belt, but serve the purpose of equalizing the angular velocity. A heat engine that is not only single-acting but develops its energy only once in two revolutions of the crank, depends for the steadiness of its rotation upon the weight of the flywheel, and with a given weight of flywheel the higher the speed the greater the regularity. The straight line principle with heavy flywheels forming part of the crank placed centrally between the two bearings presents a great weight of parts to receive the concussion of the explosive charge that occurs just after the crank has passed its dead center, so that the journal bearings outside of the flywheel receive but a small portion of the shock, and each journal receives an equal amount of the impulse not absorbed by the heavy wheels that carry the crank-pin. Immediately after the explosion the pressure falls and the expansion of the heated gases continues to act on the piston with a steady but gradually decreasing force until the exhaust valve opens at the end of the half revolution.

The ends of the shaft project equally beyond each bearing, enabling the band pulley to be put on one or the other side so that the engine may be erected right or left-handed, as the circumstances require, or two band pulleys, one on each side, can be used to drive separate machines.

It is quite evident that the line pursued by the Priestman Co. in adopting a design that has become a favorite in America, a design that is theoretically correct in principle, has at once tended to disarm criticism, and such engines as have been constructed on this plan have demonstrated the correctness of the principle.

There is in this country a great want for a quick running prime motor that can be adapted to lighting and pumping for farm work, and for driving light machinery generally, the demand being for some independent installation where steam is not available for many reasons. The Priestman petroleum engine does not, therefore, come in competition with steam engines and boilers, as it is not subject to the laws that govern the management of steam and can be operated by any person of ordinary intelligence. When once started it needs no attention as long as the supply of fuel in the tank holds out. It is to be classed with the higher type of labor-saving devices. The great rapidity with which electric lighting has come into favor in America makes a growing necessity for an engine of this kind that can readily be erected and operated without the skilled attention required by steam engines and boilers.

As an instance of the very perfect combustion that takes place in engines of this kind, I would state that I was present at the end of a five weeks' test of one of the new style machines, working with high efficiency, and when taken apart it showed no deposit in any part of the cylinder or valves, and everything was in as perfect order as when the machine was started. The platina points for the ignition were as clean and bright as when they were put in.

Bearing upon this engine it may be well to call attention to a recent departure from ordinary practice where compressed air is used to drive rock drills and other mining machinery. The loss of heat incident to transmitting power by compressed air throughout long lines of pipe has suggested the placing of the compressor as near as possible to the drills to be operated and driving the compressor by electricity and not by steam.

Several of the electrical companies are now designing motors that are intended to operate compressing machinery, the whole apparatus being in a measure portable, and in tunnel work the electric compressor advances with the drills and keeps near enough to them to be out of reach of the blast, but near enough to furnish the air quite hot to the drill cylinder.

This is mentioned as suggesting a probable use for the Priestman petroleum engine which can be readily arranged to drive the compressor pumps, and be so adapted to operate the drills without the necessity of the electrical plant and the transmission of electricity by wire to the compressors.

It is expected that a demand for the Priestman engine will come from the railway companies, who want an engine of small capacity to drive a dynamo that will charge storage batteries for lighting and be independent of the locomotive, keeping up the supply of light when the cars are uncoupled and are being shunted or standing on sidings. The Priestman engine is well adapted to this use.

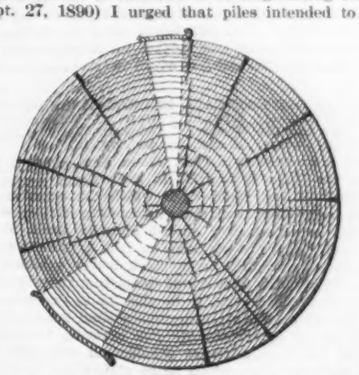
The Board of Underwriters has examined the Priestman engine and found it safe as regards fire risks, provided the petroleum is handled with care and under present conditions when being taken from the barrel to the reservoir of the engine.

In competing with gas engines, petroleum costs less in the United States than in England, while gas is much higher in price in the States than in England. The amount of country at present supplied with illuminating gas is small compared with that unsupplied, limiting the use of gas engines to the gas-furnished areas or necessitating the erection of gas producers to feed the gas engines. The two flywheels take the place of the forged crank as seen in the engines built in Great Britain. Special machine tools have been made in America for boring the eyes and crank-pin holes in flywheels of this kind, which make the built-up crank more exact in the parallelism of the shaft and crank-pin than in the case of cranks cut out of the solid. The pin also is made much longer and larger in diameter, presenting increased wearing surface. The argument is that as the momentary great pressure in a 10-HP. engine crank is as great as the pressure on a 30 or 40 HP. engine crank, the crank should be made of the same size as would be used on the larger steam engine. This can be accomplished in the compound crank without the loss of metal incident to the steel crank cut from the solid forging.

CHARRING PILES BEFORE CREOSOTING.

By William Kennish.*

In an earlier communication to Engineering News (Sept. 27, 1890) I urged that piles intended to be



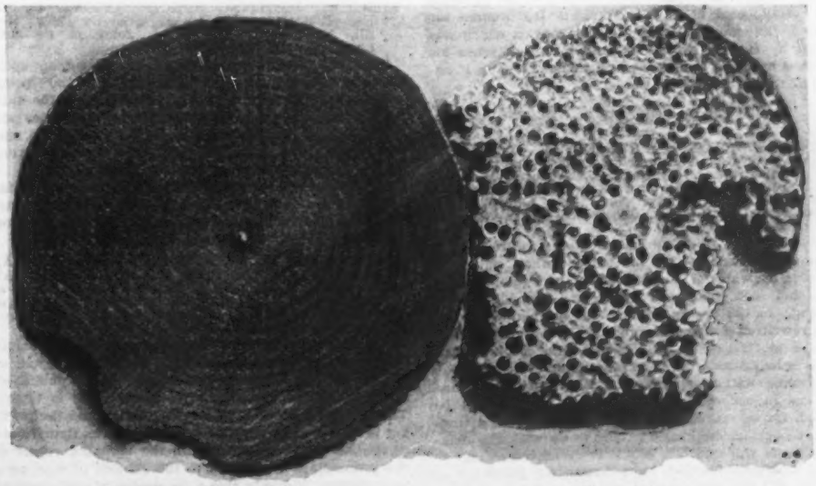
Section of Creosoted Pile with Inner Bark not Completely Removed.

driven in waters infested by the teredo or limnoria be charred before treatment for reasons that had then demonstrated themselves to me, namely, that an armor of charcoal would repel boring insects by offering them no nutriment, and that the surface throughout being rendered more permeable, the antiseptic fluid enters the wood more readily.

The last reason I wish to reinforce by a recent experience at these works. Having to shorten some piles that had been treated without charring, it was discovered that the transverse sections sometimes exhibited wedge-shaped portions extending from the center to the outside which had not received the antiseptic fluid. An examination to discover the cause of this failure demonstrated that pieces of the thin interior epidermis, which had escaped the axes when the pile was stripped of its bark, had prevented the passage of the oil to the outside of these untreated sections; it was also shown that the creosote oil when injected from the side of the log pursues the lines of the medullary rays toward the pith, and that there is no passage of the fluid across them. Thus the sections shielded by the inner skin of the bark which had not been removed in peeling had been entirely deprived of oil. It is self-evident that if these piles had been charred this evil would have been removed.

The cost of charring is so slight and the advantage is so great that I would strongly advise engineers to specify that piles for marine waters shall always be charred. If only that portion of the pile which comes in contact with the water be charred, omitting that which is driven into the bottom, the advantage is additional in the respect that the part exposed to attack receives a greater proportion of the preservative.

So far as the teredo is concerned, however, charring alone is of little value, as will be seen by the accompanying photograph showing sections of two 6-in. logs which the writer submerged in the Banks Channel, an ocean inlet about eight miles from this city. The section so thoroughly eaten was well charred, but not otherwise treated, while the section untouched by the worm was both charred and creosoted. These logs were chained together and were subjected to the same exposure. They were submerged from May to September of last year.



Charred and Creosoted. Charred Only

SECTIONS OF TWO 6-IN. PILES EXPOSED TOGETHER IN TEREDO-INFESTED WATERS.

* Engineer, Secretary and Treasurer, Carolina Oil & Creosote Co., Wilmington, N. C.

The sailing ship "Roanoke," launched at Bath, Me., this week, is said to be the largest wooden ship afloat. Her length is 311.2 ft.; breadth, 49.2 ft.; depth, 29.2 ft.; height under spar deck, 9 ft.; gross tonnage, 3,539 and net tonnage, 3,400.4. She is designed for the California trade.

A steam revenue cutter will soon be constructed for the Treasury Department. She will have a displacement of 412 tons, and will be 160 ft. long on the water line, 170 ft. 8 ins. long over all, 27 ft. beam, 13 ft. 6 ins. depth of hold, and 6 ft. 6 ins. draft. She will be driven by two independent triple expansion engines, with cylinders, 11¾ × 24 ins., 16½ × 24 ins. and 26½ × 24 ins., driving twin screws and developing 800 I. HP. at 175 revs. per minute. Steam will be supplied by a double ended tubular boiler, with 2,415 ft. of heating surface and 76 sq. ft. of grate area. A Towne water tube boiler will be fitted for use when the main boiler is not in service. The high pressure and intermediate cylinders will have piston valves, and the low pressure cylinders slide valves, all with link motions. The boat will have 6-pdr. Hotchkiss rapid fire guns, and will carry 40 to 60 men and 8 officers.

PERSONALS.

Col. E. C. Smeed, Chief Engineer of the Union Pacific Ry., died at Omaha, Neb., Aug. 24.

Mr. W. R. Storey has been appointed Assistant Engineer to the East Side Sewer Commission, at Rochester, N. Y.

Mr. John Medway has been appointed Superintendent of Motive Power, of the Fitchburg R. R., vice Mr. Orland Stewart, resigned.

Mr. W. E. Crane has been appointed engineer in charge of sewer work, by the West Side Sewer Commission, Rochester, N. Y.

Mr. W. H. Calhoun has been appointed Chief Engineer and Superintendent of the Gurleys & Paint Rock Valley Ry., with office at Gurleys, Ala.

Mr. C. J. Parker, formerly of the Lehigh Valley R. R., has accepted a position with Mr. J. M. Floesch, Chief Engineer of the Clearfield & Mahoning R. R.

Mr. W. P. Rounds, civil engineer, formerly Superintendent of Water-Works at La Salle, Ill., is in charge of sewer construction and street paving at Menominee, Mich.

Mr. Bernard Fiend, M. Am. Soc. C. E., of Chicago, has been engaged as engineer for the water supply of the World's Columbian Exposition. He will continue his private practice.

Mr. William Craig has been appointed Roadmaster of of the Seattle & Montana, the Fairhaven & Southern and the New Westminister & Southern railways, with headquarters at Seattle, Wash.

Mr. W. T. Manning, Assistant Chief Engineer of the Baltimore & Ohio R. R., has been appointed Chief Engineer of the Baltimore Belt R. R., vice Major Richard Randolph, who has been appointed Consulting Engineer.

Profs. W. C. Unwin and George Forbes, hydraulic and electrical engineers of London, are now at Niagara Falls, in the interest of the Cataract Construction Co. Both of these gentlemen are eminent authorities in their special lines.

Mr. George Stanwood, Superintendent of the Jamaica Pond Aqueduct Corporation, died at Charlestown, Mass., Aug. 25. He was born at Newburyport, Mass., in 1819. In 1864 he was appointed Superintendent of Meters of the Cochituate Water Board, which later became the Boston Water Board. In 1881, upon the death of his brother, Charles Stanwood, then Superintendent of the Jamaica Pond Aqueduct Corporation, he was appointed his successor, and has held the position since.

Col. Stephen S. Lee died at Baltimore, Md., Aug. 22. He was born in South Carolina and was educated as a civil engineer. In 1835 he directed the construction of the Providence division of the New York, Providence & Boston R. R. In 1836 he was sent to Illinois to examine and report upon the advisability of Eastern capitalists contracting to build railways and deliver to the state completed, accepting state bonds in payment. Mr. Lee reported that the project was inadvisable at that time, and the panic of 1837 justified his views. In 1843 he began the developing of the immense Cumberland coal fields in Maryland. He became the agent for the Mount Savage Coal & Iron Co., which was owned by English capitalists, and in a few years his business assumed immense proportions. He was President of the Swanton Coal Co.

NEW PUBLICATIONS.

A TEXT-BOOK OF EXPERIMENTAL ENGINEERING. For Engineers and for Students in Engineering Laboratories.—By Roila C. Carpenter, M. S., C. E., M. M. E., Assoc. Prof. Experimental Engineering, Cornell University. New York: John Wiley & Sons. 8vo., pp. 709; 250 cuts; 58 pp. tables; fair index; $6.

This work is a third edition of "Notes on Mechanical Laboratory Practice" by the same author, published in 1890; of which a second edition was published in 1891, and soon exhausted by an unexpectedly liberal demand. In the present volume the original work has been rewritten and much enlarged, so that the change in title to "Text-book of Experimental Engineering" seems to be justified. It is an interesting evidence of the importance which experimental laboratory work has assumed in our colleges that such a work should be needed, for of course its largest use will be as a text-book, though all engineers having to do with the making of tests will find it a useful work of reference.

The book opens with a brief theoretical discussion of methods for the reduction of experimental records, and it is this opening which appears to us to demand the severest criticism, not for sins of commission, but of omission. Only 17 pages are devoted to this most vital of all fields in such work, for every experimenter knows from practical experience that in the actual work of new tests, which are exploring unknown fields and not merely beating over old grounds for the sake of practice, the generalization of the experimental records, to find out what they really mean and show, is by far the hardest and most dubious part of the work. A number of instances might easily be advanced where the value of the most costly and elaborate experiments has been completely neutralized by erroneous methods of generalization. We could have wished that a few pages at least on this subject, pointing out the nature of the danger and how it could best be avoided, had been included in this volume. It is sadly incomplete without it, for the general tendency of the work, if we have caught it fairly, is to instil into the youthful mind that all they have to do is to make the experiments and apply the methods of least square to the results, or plot them, and they will tell their story at once. No doubt this is true of the narrow round of experiments in well beaten paths to which college undergraduate experimenting is chiefly confined; but it is far otherwise in almost every kind of original investigation, and surely this should be made plain in some way, or one of the fundamentals of "experimental engineering" has not been taught.

Otherwise than this the work seems a most convenient and meritorious one, and it might be answered to the criticism which we have made that the scope of the work is not to teach how to generalize safely from experiments, but rather to teach how to make the experiments themselves. This last certainly is done in a careful and thorough way. Beginning with general apparatus, like slide rules, verniers, planimeters and micrometers, nearly all the approved forms of testing machines for strength of materials, lubricants, measurements of power, pressure, temperature, heating power and the like are fully described, as well as the approved methods for testing prime movers of all kinds. Much of the information contained in the work is to be found elsewhere only in scattered papers and articles. It was a work well worth doing to combine all this information into one volume, as in the present revised and enlarged edition, which is practically a new work.

SHOULD THE RAINFALL EXPERIMENTS BE CONTINUED?—By Edward Powers, C. E., author of "War and the Weather," Delavan, Wis., published by the author. 12 mo., pamph., pp. 15.

This is an answer to Prof. Simon Newcomb's paper, "Can We Make It Rain?," in the "North American Review" of last October, in which the experiments of the rainmakers and their astonishing claims were severely criticised. We quoted liberally from Prof. Newcomb's paper in our issue of Oct. 3. Mr. Powers' argument shows that he is much better qualified to rank as a scientist than "cloud compelling Dyrenforth." The only trouble seems to be that he is endeavoring to prove his pet theory, and turns a blind eye on facts which do not agree with it. For example, he triumphantly instances a recent powder-mill explosion, at West Berkeley, Cal., which broke plate glass windows in San Francisco, 12 miles away, as a contradiction of Prof. Newcomb's statement that the concussion of an explosion produces only an infinitesimal effect at a distance. He forgets, however, that an explosion of this sort ought to have some effect on the weather, according to his theory, and if it did not, so much the worse for the theory.

ELECTRIC LIGHTING SPECIFICATIONS, for the Use of Engineers and Architects.—By E. A. Merrill, New York. The W. J. Johnston Co. Ltd. 12mo, pp. 176. $1.50.

This work is intended as an aid in constructing specifications for individual installations, and the specifications here given are mainly founded upon the rules and regulations adopted by insurance companies and electric light associations and are intended to be used with these. The rules and regulations of these several bodies are added to this work for ready reference.

The list of specifications covers almost every installation in use at present, and the arrangement is such as to prove eminently useful to the electrical engineer and those dealing with electrical plant.

PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION—Held at Saratoga, N. Y., June 20, 21, 1892. Edited by Angus Sinclair, Secretary; Published by the Association. 8vo.; paper, pp. 295; $1.50.

The Master Mechanics' Association is to be complimented on the promptness with which this report of the convention, held only two months ago, is published, and also on the excellent style in which it is issued. The new front cover is of pleasing design and the printing is in the main very well done. No less than 70 out of the 203 pages which contain the verbatim report of the proceedings is devoted to the subject of compound locomotives. There is also a discussion of some interest on firebox steel. A full report of the convention was given in our issues of June 23 and 30.

SOCIETY PROCEEDINGS.

CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS.—The annual meeting was held at Meriden, Aug. 24. The object of the meeting was to inspect the sewage disposal works designed by Carroll Ph. Bassett, of Orange, N. J., and now in process of construction under W. S. Clark, City Engineer. The separate system is used and the sewage is to be disposed of by intermittent downward filtration upon sand plains near South Meriden. Only the outlet sewers and disposal grounds are being constructed. The system within the city will be begun next year. The main feature of interest to the association was the disposal works now nearly completed.

THE NORTHWESTERN ELECTRIC LIGHT ASSOCIATION was organized by the electricians, managers and officers of the electrical works of the northern peninsula of Michigan and northern Wisconsin, on Aug. 19, at Marinette, Wis. The following officers were elected: President, H. C. Higgins, of the Marinette Gas, Electric Light & Street Ry. Co.; Secretary, T. A. Pamperin, Manager of the Citizens' Light & Fuel Co., and President of the Electric Mfg. Co., of Oconto, Wis., and Treasurer, Louis Lusk, President of the Edison Electric Light Co., of Antigo, Wis.

The object of the association will be the regulation, settlement and exchange of ideas concerning matters of mutual interest in the electrical business. After the adjournment of the meeting the visitors inspected the electric lighting plant and street railway under the management of Mr. Higgins. The next meeting will be held Oct. 12, at Oconto, Wis.

NEW ENGLAND ROADMASTERS' ASSOCIATION.—The tenth annual convention of the association was opened at Cooley's Hotel, Springfield, Mass., on Aug. 24 at 1:30 p. m., Pres. F. C. Clark presiding. After a brief address by the President, the roll was called, showing 28 members present. The report of the Secretary and Treasurer showed the financial condition of the association to be better than ever before. The total receipts for the year were $719 and the total expenses $614, leaving a balance of $85, besides a balance from the preceding year of $184.

The ballot for officers followed, the following being elected: Pres., C. B. Lentell (B. & A.); Vice-Pres., F. Holbrook (N. Y., N. H. & H.); Secy. and Treas., G. L. R. French (B & M.); Chaplain, E. W. Horner, and Executive Committee (which also includes the preceding officers ex officio), F. E. Sibley, F. C. Clark, S. B. Bodwell and W. T. Mosher.

The reports of the committees on the subjects noted last week, were then taken up for discussion:

The committee's report on heavy and light rail sections and proper difference in track labor therefor was in substance that, other conditions being the same, it did not on the whole require any additional work to get the full value and use of the heavier rail after it was once in place. There was, perhaps, some increase in labor in curving and handling the heavier rail preparatory to laying it, but this was of small moment compared with the advantages gained from its use. An increase in the weight of rails was needed to keep pace with the increase in the weight of locomotives and cars, both as a matter of safety and to save labor on the track. Several advantages were to be gained by the use of the heavier rail. On account of its greater stiffness there was less deflection under the load and consequently easier riding track and there was less tendency of the rails to creep. Stronger and stiffer joints could be made, which, with the wider heads affording greater wearing surface, insured a longer life to the rail, and the wider base increased the life of ties and lessened the labor of renewal. The heavy rail was less liable to break and in general its life was much longer than the light rail. In regard to surfacing, cleaning and other section work it could not be said that it was appreciably increased by using a heavier rail. Taking into consideration all things, the committee considered that the heavier rails would not have to be renewed as often as the lighter, which is a very large saving of labor, and thought that the extra labor required in the preparation and handling of the heavier rail would be of little account when compared with the labor saved by the longer time between renewals, stronger joints, stiffer and wider rails and a generally more satisfactory track. The committee presented the following further questions for discussion: (1) What should be the maximum weight of the rail to the yard? (2) What proportion should the base of the rail be to its height? (3) Should the same number of ties per mile be used with the heavy rail as with the light? (4) Is there as much need to use tie plates with the wider-based heavy rail to obtain the full value of the ties?

The discussion on the report was opened by Mr. J. W. Shanks, who considered the use of a heavy rail not only desirable but necessary with the present heavy rolling stock. He would have the rail proportioned in weight to the heaviest locomotive used; for a 50-ton locomotive a 50-lb. rail, and for a 100-ton locomotive a 100-lb. rail, or, in other words, make the weight of the rail in pounds equal the weight of the heaviest locomotive used in tons. He would use from 2,900 to 3,000 ties per mile and make the rail base 6 ins. wide and the height of the rail 5 ins.

Mr. J. W. Drew thought that there was less track labor with a heavy rail and considered the extra labor of preparing and putting it in the track to be small. The weight required depended on the traffic. Rails weighing from 75 to 95 lbs. would be sufficiently heavy for the traffic on New England roads. He would put ties 10 ins. apart in the clear.

Mr. G. W. Bishop considered the difference in the labor in laying heavy and light rails to be small, and that once laid labor was saved in surfacing and alinement, and that it was easier to keep the gage and the life of both ties and spikes was prolonged. He would place the maximum weight demanded by the present rolling stock at between 90 lbs. and 100 lbs., and would have a base of 6 ins. and a height of 5 ins.

Mr. W. T. Mosher considered a 95-lb. rail to be sufficiently heavy to do the work required by the present weight of rolling stock, and thought that a 90-lb. rail was the minimum weight which should be used. In regard to the comparative dimensions of base and height there was something to be considered besides the effect upon the ties. The great trouble with the heavier rails rolled at present was their poor quality compared with that of some of the old lighter rails. On account of the thinness of the base the rail had to be rolled so fast as to prevent the metal in the head from thoroughly annealing. He would make the base and height equal.

Mr. W. E. Clark placed the minimum weight for present rolling stock at 70 lbs., but wanted a first class quality of steel. The base should be as great as the height anyway. A base of 6 ins. and a height of 5 ins. was a very good section. He used 3,200 ties per mile.

Mr. E. K. Post thought that an 85-lb. rail was about the right section. He would not advocate an extremely heavy section and thought that fully as much wear could be obtained from an 85-lb. rail as from a 100-lb. rail.

The testimony of the other members who spoke varied but little from that already given. There seemed to be a general opinion that better material was needed, and that without an improvement in this direction many of the advantages of the heavier rail were largely nullified. In closing, it was—

Resolved: That the report submitted by the committee be accepted as the sense of this convention, and that the four questions attached to this report be answered as follows: (1) That the weight of the rail should be at least 85 lbs. per yard for the heavy traffic of the present time. (2) That the height of the rail should never exceed the width of the base and if the rail can be properly rolled the width of base should exceed the height. (3) That the same number of ties per mile should be used with the heavy rail as with the light. (4) That tie plates should be used with all present dimensions of rails, as the life of the tie will thereby be prolonged sufficiently to more than pay for the tie plates besides the other advantages derived from their use.

Small Culverts and Cross Drains.—The report of the committee on this subject was very short. It was in brief that the best material for small culverts is stone laid in cement. They should be arched over when it is practicable to do so, and should be laid with the bottoms flagged or paved with stone set on edge and grouted with cement mortar. Cross drains should be constructed of good sound plank, either white oak, yellow pine or chestnut.

Mr. W. E. Clark opened the discussion. He did not favor an open culvert of any kind and thought that they could generally be avoided. For culverts up to 8 ft. span he recommended a covering of flagging where sufficiently large stones could be secured. The bottoms should be of flagging or pavement, and a good quality and liberal quantity of cement mortar should be used in the work.

Mr. P. D. Brennan agreed with Mr. Clark as to use of flagging for covering culverts up to 8 ft. span, and for greater spans recommended the use of rails when there was not sufficient height to construct an arch.

Mr. J. W. Drew regarded the use of flagging for covering culverts of 8 ft. span as dangerous unless stones could be obtained at least from 2 ft. to 2½ ft. thick. He preferred arches for all culverts over 6 ft. span and for small culverts used cast iron pipe. Slightly imperfect pipe could be used, and would satisfy all purposes, besides costing much less than perfect pipe.

Mr. E. K. Post had formerly used flagging for covering culverts but was now building many with stone masonry walls and brick arches. For cross drains he used a 12×12-in. box of 2-in. chestnut plank.

Mr. J. R. Patch used iron pipe for all culverts of less than 3 ft. space and for culverts of from 3 ft. to 5 ft. span stone masonry walls with a flag stone covering. For spans over 5 ft. he used double culverts. The convention then—

Resolved: That all small culverts should be covered and all cross drains open.

That all culverts up to 4 ft. width should consist of one or more cast iron pipes laid on a sharp incline, with the ends set in faces of rubble masonry laid in cement mortar, and should have not less than one foot of ballast between their tops and the bottoms of the ties.

That we consider iron pipe as cheap and more serviceable than stone.

That cross drains be of 2-in. plank; oak, chestnut or hard pine, of such width as to allow them to be placed between the ties.

Fire Damages.—The committee on this subject presented the following report which was adopted without discussion:

(1) We recommend that the location be cleared of all old ties, plank and bark, and kept clean by removing all old material as soon as removals take place. (2) We recommend that all brush, weeds and grass be mowed between the middle of July and middle of September, and burned as soon after as possible. (3) It is our opinion that the netting of the smoke stack should be thoroughly examined at the end of each trip, as well as any other part of the locomotive. (4) We suggest that each section foreman be provided with proper blanks, which will give full particulars of all fires, and that he be required to fill out one for each and every person who has had property damaged by fire, and promptly forward it to the roadmaster of his division for approval; after which the claim agents should have in charge the settlement of the damages.

Economy of Using Cheap and Inferior Material and Tools.—No report was presented by the committee on the fourth subject. The question was, however, briefly discussed, and the following resolution passed:

Resolved: That we denounce the practice of purchasing cheap and inferior materials and tools as detrimental to the best interests of a railway.

In addition to the regular reports of the several committees, a paper on rail sections was read by Mr. W. F. Ellis, and several questions suggested by the reports were informally discussed. Mr. Ellis presented a collection of sections used in New England and elsewhere, most of which have already been shown in these columns, and proposed a number of questions in regard to them and track practice generally, which there was not time to fully discuss.

The following interesting table, showing in condensed form the proportions of most of the more important rail sections now in use in New England, accompanied Mr. Ellis' paper, with drawings of most of the sections. We regret that we are unable to find space for the paper, partly on account of its length and many illustrations, and partly because it assumes as an admitted fact, what is denied by an immense majority of engineers who have studied the matter, that the corner of the rail should be rounded off "to fit the flange," and if this be not done, more rather than less of the justly called "precious metal" in the fillet of the flange will be worn away. This latter view is still held by engineers whose arguments are entitled to attention and opinions to weight; and our columns are always open to careful discussions of this question upon its merits, but to print papers assuming as a known fact what is generally denied would be to disseminate misinformation.

It was decided to hold the next convention of the Association at Boston, Mass., on the third Wednesday in August. The convention then adjourned, after passing votes of thanks to the hotel proprietors, the Connecticut River R. R., and to the supply men.

Dimensions of Rail Sections of the Chief New England Railways.
Accompanying Paper of Mr. Wm. F. Ellis.

	Lbs.	Width of base.	Height.	Head.							Fish Angle.	Fillet Radius.	Web.			Thickness center base.
				Thickness.	Width.	Corner Radius.	Sides.			Top Radius.			Thick.	Sides.		
							Straight Sides.	Slope in.	Slope out.					Straight.	Radius.	
Maine Central	67	4⅛	4⅛	1⅝	2⅝/32	7/16	No	No	1/16	10	13	¼	⅛	No	8	3/4
Conn. River	70	4⅛	4⅛	1⅝	2⅝/32	7/16	"	"	1/16	10	13	¼	5/16	"	8	3/4
Housatonic	70	4⅛	4⅛	1⅝	2⅝/32	7/16	"	"	1/16	10	13	¼	5/16	"	8	3/4
Conc. & Mont.	72	5	4⅛	1 39/64	2⅝/32	7/16	"	"	5/32	10	13	¼	⅛	"	11	23/32
Boston & Me.	72	5	4½	1 5/16	2⅝/16	5/8	"	"	1/8	10	11	¼	⅛	"	10	11/16
"	75	5	5	1 5/16	2¾	½	Yes	.....	.....	12	11° 30′	¼	5/16	Yes	.....	49/64
Prov. & Worc	72	4¾	4¾	1¾	2⅝	½	No	1/16	.....	10	20	¼	⅛	"	.....	11/16
N. Y., N. H. & H.	74	4¾	4 11/16	1¾	2⅝/16	5/8	"	1/16	1/16	15	17	5/16	5/16	No	15	¾
N. Y. & N. Eng.	75	5	5	1 13/32	2⅝/16	5/8	"	1/16	1/16	12	14° 2′	⅜	17/32	"	10	37/32
Central Vt.	75	4¾	5	1¾	2⅞/16	½	"	1/16	1/16	14	4 to 1	⅜	17/32	"	14	¾
Fitchburg	76	5	4¾	1 11/16	2¼	⅝	"	1/16	⅛	Flat.	14° 30′	⅜	½	Yes	.....	13/16
Old Colony	78	5	4¾	1¾	2⅝/16	⅝	"	1/16	1/16	11	4 to 1	7/16	17/32	No	.....	29/32
N. Y., Prov. & Bost.	78	5	4 23/32	1 21/32	2⅞/16	5/8	Yes	.....	.....	12	14	7/16	17/32	"	10	13/16
Boston & Albany	95	5½	5 1/32	1 5/16	2 27/32	5/16	No	No	1/16	14	14	½	⅝	"	14	1

Note.—Thickness of head is at end of corner radius on side of head.

Exhibits.

The following is a list of the companies having exhibits of their various specialties at the convention:

Pneumatic Gate Co., Chicago, photographs of Pneumatic Railway Gate in use; Elastic Nut Co., Milwaukee, Wis., samples of elastic nuts; the Brush interlocking Bolt Co., Philadelphia, Pa., small models and samples of interlocking bolts; Continuous Rail Joint Co. of America, Newark, N. J., samples of joints attached to rail; Bee Hive Spindle & Flier Works, Lawrence, Mass., samples of triple-threaded drive screws and rail clamps; Bush Cattle Guard Co., Kalamazoo, Mich., Bush Cattle Guard; the Q. & C. Co., Chicago, Ill., Servis tie plates and Bryant metal sawing Machine; Keeler, Lyon & Co., device to prevent the spreading of rails at curves; Reinforced Rail Joint Co., Lancaster, N. H., sample of joint fastened to rail; the McMullen Woven Wire Fence Co., Chicago, Ill., samples of woven wire fencing; Dilworth, Porter & Co., Limited, Pittsburgh, Pa., samples of Goldie spikes and tie plates; Ruffner & Dunn, Philadelphia, Pa., samples of single and double automatic nut locks; The Standard Combination Tie Plate and Brace Co., Philadelphia, Pa., models of combination tie plate and rail brace; Fairbanks, Morse & Co., Chicago, Ill., samples of track and bridge jacks and pressed steel car wheels; The Positive Lock Washer Co., Newark, N. J., samples of positive lock washer; The Portable Rail Saw Co., New York, samples of saw blades; Long's Truss Rail Joint Co., Chicago, Ill., samples of joint fastened to rail; Standard Nut Lock Co., Newark, N. J., nut locks; American Nut Lock Co., St. Louis, Mo., nut locks; Ramapo Iron Works, Hillburn, N. Y.; Keegan & Halpin, New York, Wells light; American Ry. Equipment Co., New York, Servis nut locks; J. H. Sternbergh & Son, track bolts and nuts; American Washer & Manufacturing Co., Newark, N. J., nut locks and washers; Weir Frog Co., Cincinnati, O., steel die-formed rail braces; Sheffield Velocipede Car Co., Three Rivers, Mich., velocipede car; National Surface Guard Co., Chicago, Ill.; Pettibone, Mulliken & Co., Chicago, Ill.

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Sept. 2. Secy., E. K. Smoot, 903 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 2. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Sept. 3. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Sept. 3. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St. Secy., L. F. Randinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 8. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Sept. 8. Secy., O. H. Landreth, Nashville, Tenn.
WISCONSIN POLYTECHNIC SOCIETY.
Sept. 12. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Sept. 12. Secy., C. L. Annan.
NEW ENGLAND RAILROAD CLUB.
Sept. 12. Secy., F. Curtis, B. & A. R. R., Boston.
DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 13. Secy., Geo. H. Angell.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept. 13. Seattle, Wash. Secy., F. H. Warner.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC.
Sept. 14. At Detroit, Mich. Secy., Robt. McKee, Kent, O.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Sept. 15. Secy., C. F. Franson, 113 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
Sept. 15. Secy., J. F. Wilson.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Sept. 17. Secy., F. D. Jones, Helena.
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., E. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Meehan.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richardson, Brooklyn, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. R. Schick, Roanoke.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charlot, Macon, Ga.

ENGINEERING NEWS

AND

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS

CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT. } ASSOCIATE EDITORS

GEO. H. FROST..... .BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The probability that Asiatic cholera, which is now epidemic in several European ports, will reach the United States places an increased responsibility upon every engineer in charge of public water supplies or sanitary engineering works. While cholera spreads in various ways it is like typhoid fever in being most readily communicated by polluted drinking water; hence cities whose water supply is contaminated with their own or their neighbor's sewage are likely to be great sufferers if cholera once secures a firm footing. The sanitary protection of water sheds is a topic which may acquire a new and vital interest for engineers. New York City, for example, ought to adopt extreme measures for the protection of its Croton supply from pollution as soon as the disease appears in this country without waiting for cases to develop in the Croton valley; and what New York should do is an example of what should be done by every city taking water from running streams.

As for cities which take water from sources notoriously foul, like Jersey City, Philadelphia, Cincinnati, and many others, the prospective danger makes the present an excellent time to agitate the question of a pure water supply. "All that a man hath will he give for his life," and the possibility of a plague of cholera in some of these sewage drinking cities should silence effectually the plea that the present supply is as good as they can afford.

Second only to pure water supply in preventing the spread of epidemics is the promotion of cleanliness and proper sanitary precautions. The prompt removal and destruction of garbage, the thorough cleaning of streets and flushing of sewers, the provision of necessary appliances for fighting contagious disease when it appears—all these are matters which in seasons of epidemic acquire a new and great importance.

In this connection we wish to call attention to the excellent system of disinfection in use in Milwaukee, described in our issue of May 12. A disinfecting van is sent to the house where a contagious disease has occurred, and carpets, bedding, clothing, furniture, etc., are placed inside the van and subjected to a temperature of 250° until all germs are killed. This appears to be a very sensible innovation on the ordinary plan of carrying infected articles through the streets to a central disinfecting station, with the possibility of spreading the disease on the way.

The following jocular bit of correspondence from Pottsville, Pa., is respectfully referred to the people of Philadelphia for their serious consideration:

In reply to your letter of the 24th inst. I would say that all the sewage of this town is carried off by the Schuylkill River and is not utilized for any purpose except to form a part of the water supply of Philadelphia.

Pottsville, according to the last census, had a population of 14,117 in 1890. It is 93 miles above Philadelphia and even if it could be proved that its sewage does not affect Philadelphia's water supply, yet there are several other towns lower down, including Reading, whose sewage and drainage is also discharged into the Schuylkill River, the chief source of the water supply of Philadelphia. This water supply is generally admitted to be badly polluted with sewage, to which is attributed the high death rate of the city from typhoid fever in the centennial year 1876 and, in fact, for many years past, as was shown in our issue of April 21, 1892, in connection with the article on "Typhoid Fever in Chicago." A 20,000,000-gallon filtering plant is now proposed for Philadelphia, which, if successfully installed and operated will improve a part of the water supply.

But even after this improvement is effected, will it furnish a proper supply for a great and growing city like Philadelphia? That is a question for Philadelphians to ponder, for they have the chief interest in it.

As underground railways seem to be the adopted type for the proposed rapid transit system in this city, the motors to be used are of especial interest, and electric power is the one most frequently mentioned. In this connection the working of the City & South London Railway is of interest, as giving the results of practical experience with electricity. In this connection we find that at the stockholders' meeting of Aug. 5, of the London company, the Chairman mentioned that the so-called locomotive expenses had been reduced to 15.4 cts. per train-mile, as compared with 18 to 21 cts. per train mile for ordinary steam railways. This comparison is hardly fair, inasmuch as it compares the concentrated traffic of a short line of light cars to the more widely extended traffic of an ordinary railway. But it is interesting as showing what can be done with electric motors in a tunnel.

Mr. Alexander Siemens, in his late paper before the British Association, shows that two of his electric locomotives used on the City & South London Railway, with 100 HP. each, gave a practically constant efficiency record of 92%, at speeds of from 12 to 30 miles per hour. The locomotives weigh only 13½ tons each and draw a load of about 21 tons, exclusive of passengers. Though this is not a heavy load when compared with the probable train demand of the proposed New York system, the efficiency obtained is very gratifying and is convincing proof that electric locomotives can be designed to meet the prospective service.

In our issue of July 28 we published with some misgivings a communication signed "W.," in which, under cover of discussing the absurd "Irish Canal and Tunnel Project" of Sir Edward Watkin and our remarks thereon, opportunity was taken to lug in some remarks to the effect that "a minority of one-fifth in Ireland, loyal" represented about all that was industrious, honest or worthy in Ireland; that all the industries, especially, were in the hands of the "loyalists," and that all the remaining fragment of four-fifths of the population were "similar" at least to a "murderous, rum-selling crew."

We should not have done it. We admit our sin. It was a direct provocation for equally vigorous rejoinders, and we have received several such, which we feel that we cannot publish, though every one of them was in at least as good temper and good taste as the original fling which provoked them. We published the letter (with a deprecatory comment) partly from mere inadvertence, we fear; partly in pursuance of our general policy to let every man have his say when he says it with some outward respect for fairness and truth on a matter of general interest, and partly, we may confess, from an amused interest in this new evidence of the implacable hatred and contempt with which the "loyalists" look upon the rest of the inhabitants of Ireland, and which is returned with interest. The contrast between this unceasing feud of centuries and the cordial and friendly good will which has come so quickly between North and South and which exists so generally between native and foreigner, between Americanized foreigners of different races, between black and white, and (in the main) between rich and poor in this country, is one which Americans cannot but contemplate with satisfaction. To throw a new sidelight on this contrast was, we fear, an unconscious motive for admitting the paragraph containing the offensive political allusion with the rest of the letter. We cannot admit other letters in answer to it, however, devoted to politics only, though in a sense fairness demands it.

THE MODERN LABOR PROBLEM.

It is almost an axiom of mathematics that the surest test of the correctness of an equation is to test it for extreme values of the variables. If an equation holds true for the extreme limits of possible values of each, from zero and infinity, it is tolerably sure to be correct, even without testing it for intermediate and more probable actual values. If not, and the extreme values are really possible, there is something wrong about it.

Similarly, with any social or economic problem, it is often a great assistance for discerning tendencies, and getting at the "true inwardness" of any question of right and wrong, to imagine the existing conditions to be considerably exaggerated in one direction or the other. Such assumption does not necessarily assume also that the exaggerated conditions are likely soon or ever to obtain. It merely magnifies existing conditions so as to make their real nature more discernible. It aids us to see more clearly in what direction we are drifting, and whether existing conditions are tending to get better or worse.

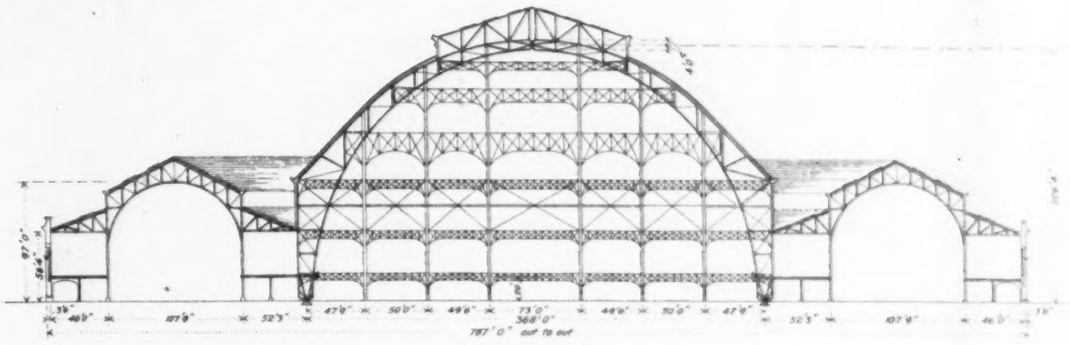
This is particularly true of the great labor problem, which has been recently forced into such prominence by events at Homestead, at Buffalo, and in Tennessee and Idaho. The time has passed for useful study of the particular points in dispute in these late unpleasantnesses. The appeal to force canceled all claim to public attention to the merits of those particular disputes. Lawlessness must be put down, by whomsoever attempted and in however good or bad a cause. Whatever else we have, we cannot have anarchy. The public peace must be restored and maintained.

Nevertheless the recent pitched battle between a large force of Pinkerton men and a larger force of strikers, and more recently the mobilization of the entire militia of four states in order to control public violence, must be admitted to be novel and portentous spectacles. Fully agreeing that the duty of the hour was and is to suppress lawlessness first and inquire into its causes afterward, now that peace is practically restored once more, the thinking fraction of the public cannot help asking whether any causes are developing among us tending to provoke appeals to force more than heretofore, and if so, what is the remedy for them. To be continually suppressing force by force, and neglecting to discern and remedy (if possible) causes tending to provoke the use of force, would be the worst kind of politics. Something like 20,000 men were under arms at once, a week or ten days ago, in order to suppress domestic violence. So wholly unprecedented a spectacle should not be lightly dismissed as if it were a mere street corner row.

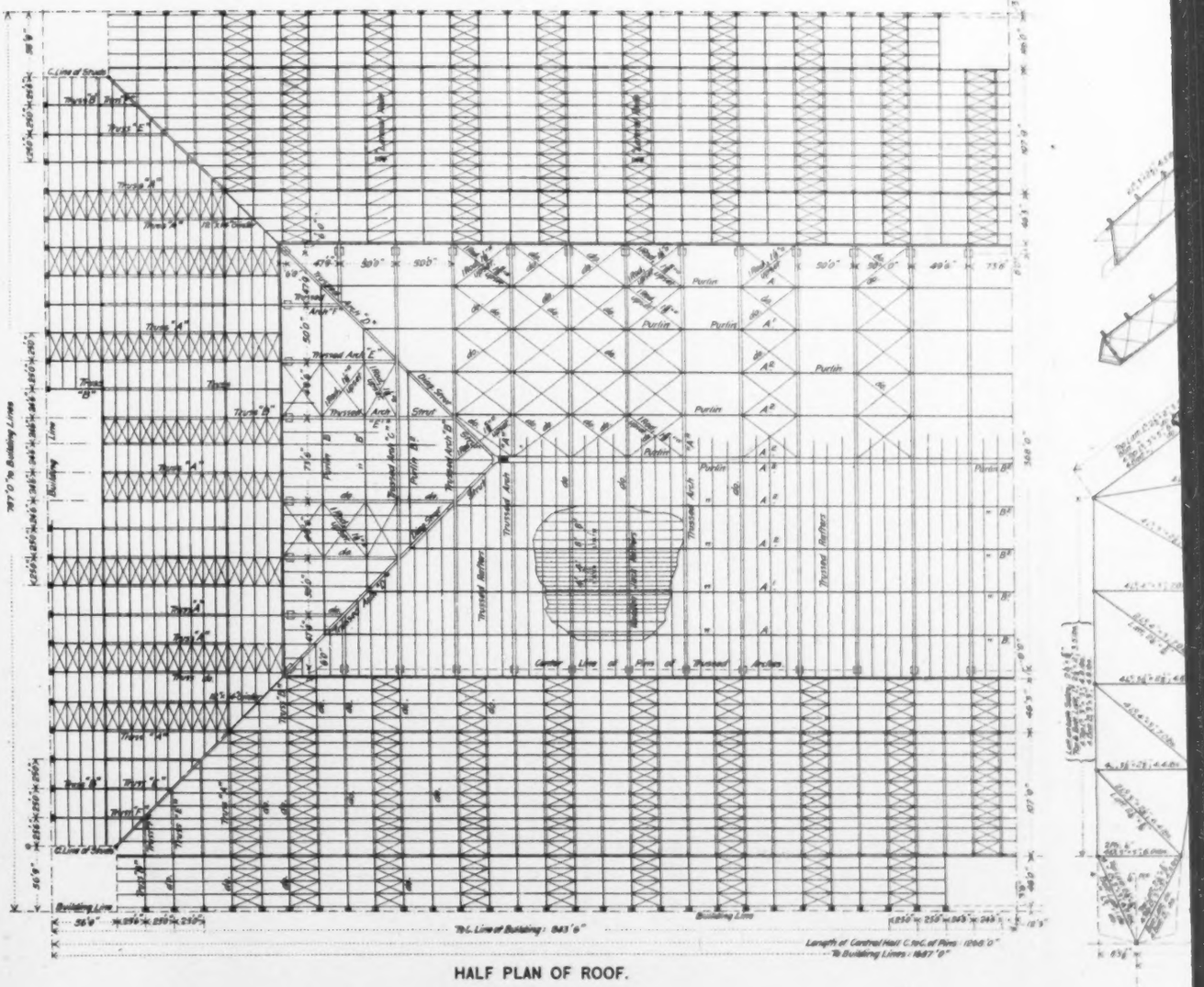
The real question which should now receive most careful attention is: Have there been any recent changes in the relation of master and man tending to be specially provocative of discord and violence, which are still tending to grow worse so as to require some new remedy; or is the increasing bitterness of labor disputes within the last two or three decades only an indication of the growing power of the miscalled "working classes" (in a land where all work hard) which will tend to adjust itself in time and disappear?

To test this, let us not trouble ourselves with the conditions of the moment; still less with the details of specific disputes, but test our problem for extreme values by considering the labor status under two extreme conditions: 1. As it was "in 1800 and little or nothing" before modern industrial conditions had begun to develope; 2, as it may be a decade or two hence should recent tendencies continue and intensify themselves.

When the century was young there were no large employers, and there certainly was no labor question as we know it to-day. An employer of more than a dozen men was an exception; an employer of more than two dozen the rare exception. The master knew all his men by sight and name. He worked with them or over them himself, and mutual friendly feelings naturally sprung up, as they always easily



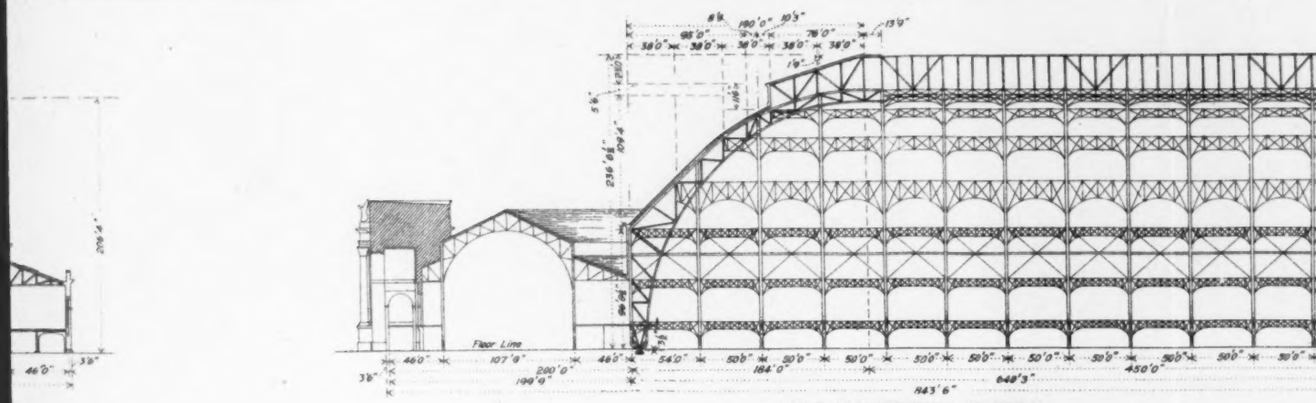
CROSS SECTION.

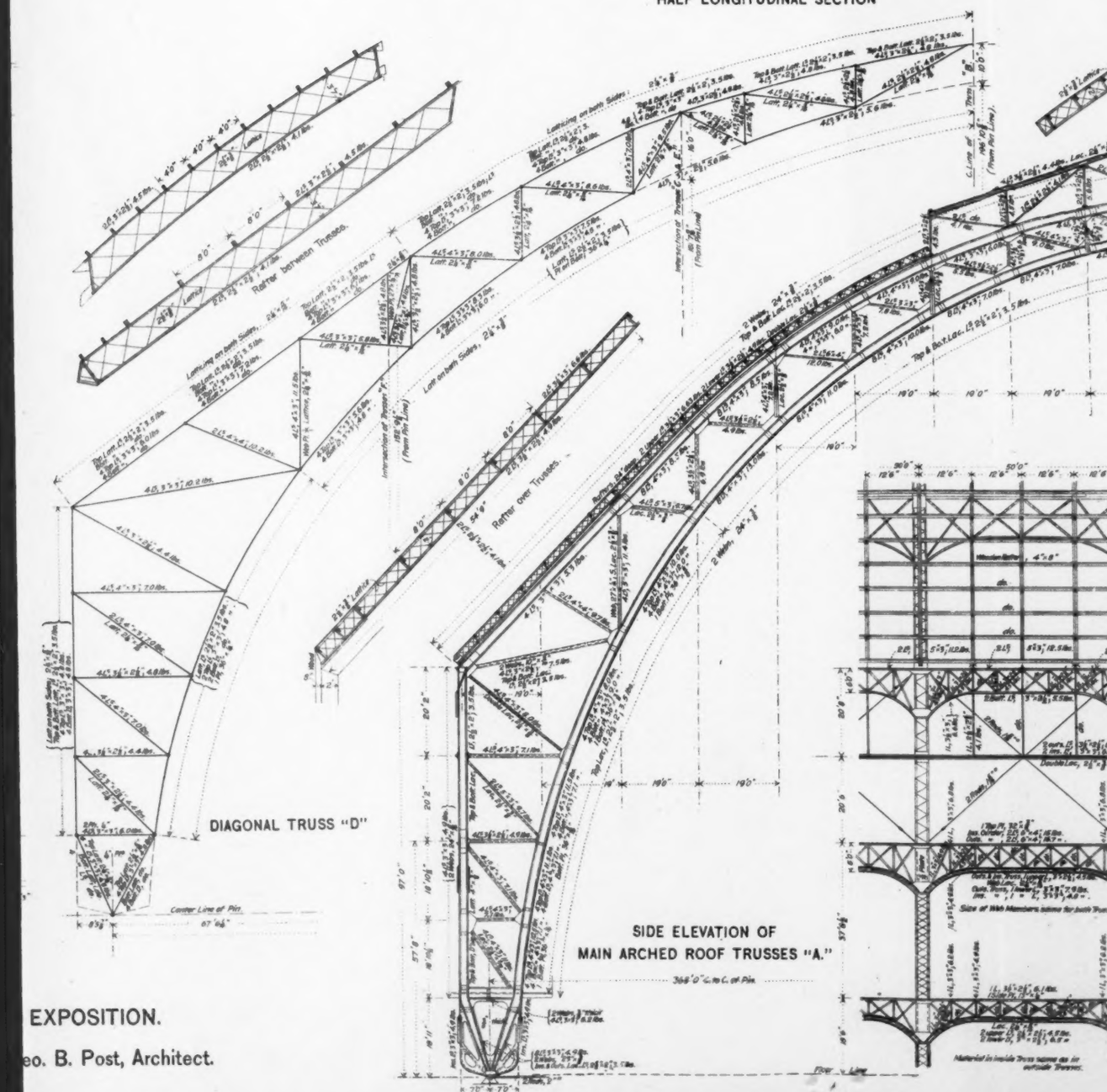


HALF PLAN OF ROOF.

MANUFACTURES AND LIBERAL ARTS BUILDING; WORLD'S COLUMBIAN EXPOSITION.

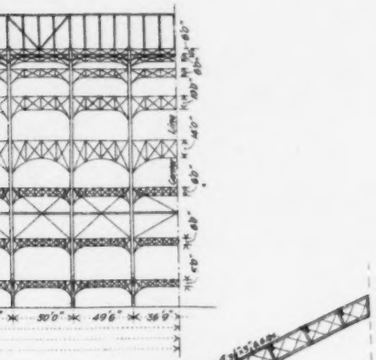
D. H. Burnham, Chief of Construction. E. C. Shankland, Engineer of Construction. Geo. B. Post, Arch

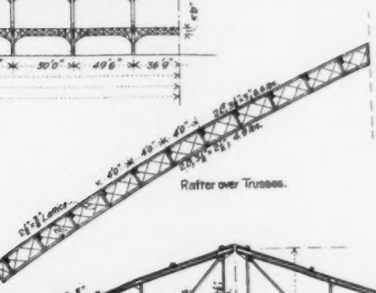


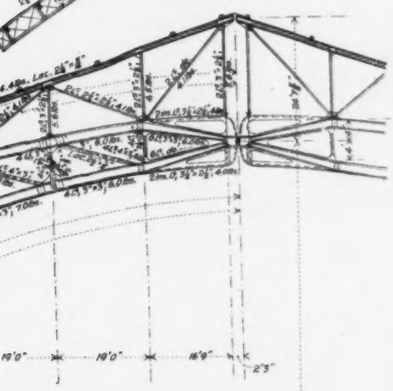


EXPOSITION.

eo. B. Post, Architect.







REAR ELEVATION OF
MAIN ARCHED ROOF TRUSSES
AND CONNECTIONS.

CHAS. HART & SONS, LITH, 39 VESEY ST., N. Y.

do in any close human relationship, but rarely without. His business was a small affair, and every workman could understand it and guess shrewdly at its profits. His capital was small, and his family's comfort depended on the continuity of his income, almost as much as the workman's. He had probably but recently risen from the position of workman himself.

The faithful workman had usually before him a reasonable hope of becoming an employer himself. His wages were an individual affair, based on his own merits only, which were intimately known. His average of reason and unreason was about the same as his employer's, simply because master and man were of like origin and training. For the same reason, he could deal on equal terms with his employer in an argument, and did not fear being overreached. An increase of his pay was not specially resisted if merited, because it meant only 25 cts. a day more to one man, a part of which was immediately returned in greater zeal and efficiency. If he was still unsatisfied with his wages, however, it was no serious matter to quit and seek work elsewhere. There were other like shops in the next street or the next town, almost as many as there were men to work in them. Similarly the employer was not greatly embarrassed if one or more of his men did leave him. He only needed two or three men to fill up, and most of his men would prefer to stay with him and get promotion.

Under these conditions there was perfectly free play of the law of supply and demand. There was and could be no "labor question," any more than there is now in the vast class of agricultural laborers in which the same conditions still obtain. Every tub stood on its own bottom. No serious friction resulted from the absolute power of the master to fix wages and discharge and employ at his pleasure. If the man did not like it, he could leave, and do better if he could. Under such conditions at least, it is evident that such absolute power was not only a legal but a moral right of the master, even when it resulted in personal injustice and wrong. Every man has the natural right to make the most of himself industrially that he can. If he rises to the rank of an employer, and finds himself so constituted that he cannot work with employees who will not lie or drink, we may despise him as a man, but we must uphold his legal and natural right to choose such tools as he can work with, and to dispense with the services of every man who, from being too truthful or untruthful, too sober or too drunken; too moral or too immoral; too civil or too uncivil, proves to be an uncongenial and unsuitable tool. Moreover, while cases of aggravated personal injustice always have occurred and always will until human nature has been made over, honors were likely to be about easy in this respect between master and man, under the conditions of long ago. They were under about equal temptations to injustice, and had about an equal chance to injure each other.

Therefore, under the old industrial conditions there seems to have been absolutely nothing but such individual cussedness as we shall have always with us to cause trouble between man and man, or between master and man; nothing which distinctly tended or tempted to injustice; nothing which law or custom needed to or could remedy. Industrial relations were wholesome, natural and friendly, even though absolute power as to conditions and terms of employment was in the hands of the master.

And what is more, as we follow down the changes from then to now, it is impossible to say at what point, if at any, any change occurred warranting a different conclusion. If the employer may rightfully have such power over 5 men, he may have it over 10, and if over 10 then over 20, and if over 20 then over 50, or 100, or 500, or 5,000 or 50,000. There is no point where any natural line can be drawn. Do not his means increase as the number of men to be paid increases? Is it not still his interest to have all his men contented; to employ only the best, and to pay enough to get the best? If he injures more men by an unjust lockout, does he not also lose more by an unjust (or a just) strike? If his force grows too large for him to know them personally, does not he know his managing staff who do know them, and does he not insist on their treating the men as he would treat them himself? If his temptation to keep down wages increases with number, does not the risk of doing so increase also?

To these and other like questions every reasonable man must answer yes, and thus many intelligent men have reasoned out that, although conditions have been gradually changing, yet their essential nature has remained the same through it all, and hence that it is neither proper nor possible to change materially the relation of master and man from that which has come down to us from ages past and has always proved sufficient. This conclusion admitted, it follows that the modern tendency to organized lawlessness is merely a kind of ebullition during the process of readjustment to changed conditions, and will in time die out.

It may be that this is so. There are not wanting some facts which tend to support it, as for example the reasonable conduct of the engineers' and firemen's unions, as shown in the late Buffalo strike. But this at least is certain: The reasoning by which this conclusion is reached is utterly fallacious, if not unsound. We do not prejudge the conclusion itself, which may be right or wrong. We only say that it is reached by a fallacy, or by begging the question, when we follow up the labor scale from 2 to 20,000 employees and say, because there is no one point on which we can put our finger as the point at which a change is demanded, therefore the conditions are fundamentally the same at the two extremes.

This fallacy is analogous to the familiar one by which it is "proved" that the minute hand of a watch can never pass the hour hand again after they have once separated. For by whatever distance they may be separated at the start, when the minute hand has reached the point where the hour hand was, the latter is 1-12 as far ahead again, and when the minute hand has reached that point the hour hand is 1-12 as far ahead as the second space again; and so we may go on for uncounted millions of finite terms, and we shall never reach the point where the hour hand will not have moved ahead a little further by the time the minute hand catches up to where it was.

And yet the minute hand "gets there, all the same," as we may quickly prove by other processes of reasoning. In like manner, we may have already reached and passed the point where other wage conditions should obtain, and yet be unable to detect that fact by the step-by-step process of reasoning.

To test this most surely let us look far beyond present conditions, and, freeing our minds from their disturbing influence, pass at once to our limit; which we have not yet reached and may never reach, but toward which we are tending. The distinguishing tendency of modern industrial life is concentration of industries into a few hands. It is certain to go still further, nay, it ought to go still further, because such concentration is distinctly economical and advantageous in its tendencies. It reduces the cost of production, and makes the sum-total of divisible products greater. We cannot stop it if we would. We ought not to stop it if we could. Regulation of this tendency is alone demanded, if anything, not suppression.

Let us suppose then that concentration has gone on until all the strike-breeding industries have been consolidated into a dozen large companies, each of which will be then, as now, dominated by a single managing mind. Let us suppose that the railways and other transportation interests are organized into three great companies; the iron and steel producers into another; the textile industries into another; the wood-working industries into another, and so on through the list. With our present population these twelve companies would average about 400,000 employees each*; but in the year of grace 19—, when our limit is reached, the employments in which large bodies of men are engaged in a common service will certainly be more important proportionately than now. Taking a total of 20,000,000 of working men between 16 and 60, for even figures, we may surmise from the data below * that society will then be organized about as follows:

Males between 16 and 60.	No.	p. c.
1. In professional and commercial callings	3,000,000	15
2. Employed by transportation companies	2,000,000	10
3. Employed by large manufacturing, mining and mechanical establishments	2,000,000	10
4. Employed in the smaller handicrafts	2,000,000	10
5. Employed in agriculture	6,000,000	30
Total	20,000,000	100

*The 1890 census figures are not yet out, but adding 25 per cent. to the figures of the 1880 census, and readjusting them slightly to correspond to known changes, the following is a fairly accurate subdivision of our 1890 population, quite sufficiently accurate for the end in view, which is illustrative only:

	No.	p. c.
Professional class ("actors" to "vet. surgeons")	830,000	5.1
Traders and business men, with their clerks and salesmen	1,410,000	8.7
Total	2,240,000	13.8
(These being the classes which, as a rule, are removed by superior good fortune from being concerned in labor disputes, or from furnishing further labor supply.)		
Engaged in transportation by land or water	1,180,000	7.2
Engaged in manufactures, mining or large mechanical	3,300,000	20.2
Total of the classes of employment in which strikes occur	4,480,000	27.4
Engaged in permanently small handicrafts, not susceptible of concentration into large establishments (country blacksmiths, carpenters, masons, etc.), estimated at about one-fourth of the census total of the class last named	1,200,000	7.4
Farmers and planters	2,880,000	17.5
Men servants and personal service	270,000	1.7
Farm laborers	5,250,000	32.2
Total of classes from which manufacturing labor is drawn, or may be drawn	9,580,000	58.8
Total men between 16 and 60, engaged in gainful occupations	16,300,000	100.0

Our twelve great companies will then average about 600,000 male employees each, or 7,000,000 in all. There will be an agricultural and small handicraft population of 10,000,000 on which to draw new recruits, those being on the whole in less desirable employments. There will be about 3,000,000 of professional and business men so raised in fortune above the rest that they do not enter into the problem.

Under such conditions each great company will, by natural selection and survival of the fittest, be headed by a perfect Napoleon of business and finance; a true great general of industry. He will have enormous wealth, for such men earn it and command it, apparently without effort. Humane and philanthropic instincts will not be likely to be strong in him any more than they are in the Napoleons of war; his genius will not run that way. But however humane in the abstract or toward men whom he knows, he will have lost all human relations with his men, the gravest change of all; that greatest softener of all human relations, personal contact and friendship, will be gone. His men will be no more to him than if they were horses or machines,—or let us rather say—than if they were serfs in Russia;—and how much are any of us lying awake nights over their sufferings from famine and pestilence? They are too far removed from us.

And besides this, the future manager will be under enormous temptations; 25 cts. per day off of each man's wages will mean $150,000 per day more profits to his company, or $46,950,000 per year, a large part of which, under usual business conditions, will go into his own individual pocket. How then will he be able to look at the wage question fairly? He will need to be more than human to do so.

The men will be almost equally unable to look at the wage question fairly. They will be utterly unable to comprehend the intricacies of such a business, and will have no opportunity to get at the facts in an authoritative way, to study or take advice upon them, if they could. They will have no sensible chance of rising into the employing class themselves and will have no sympathy with it. Their work for the most part will be highly specialized, so that if they "lose their job" they know no other trade, and will have to go back to the grade of common labor, for there will be no other employer to apply to in their own line. To an even greater extent than now they will be mere tenders of machines which will do all the thinking for them, or workers in gangs, where they will have to do just so much to keep up, and cannot do more if they would, so that personal qualities count for little. Such is the modern tendency. For example, in the great Westinghouse brake works, where hundreds of men are turning out the most delicate kind of mechanical work, there are said to be less than a dozen men in all who are in any sense mechanics or who could not be effectively replaced by an unskilled workman after two weeks' practice. They earn good wages by piece work, but of personal skill there is hardly any. The special machines have all the skill. Similarly in steel rail mills the blooms go in and the rails come out just so fast anyway, to suit the average ability. Every

man must do his work at this rate, or step down and out; more than that he cannot do if he would.

Can better conditions be conceived for fomenting envy, hatred, malice and all uncharitableness between master and man? Though both may be better off absolutely than fifty years ago, every condition of their relationship to each other will have changed, and changed for the worse. Fierce and frequent labor contests may therefore be expected, both strikes and lockouts. How will it be as to them?

Suppose the master starts it. He may be right or wrong in his position, but it is evident that the lockout will then be a terrible weapon. There will be no other trained men to take the positions of the strikers; but, nevertheless, the master will have to wait, and he will be sure to win in the end. For there will be 10,000,000 men in the community earning less than his late force, from which he can gradually recruit anew his entire force of 600,000 if he needs to. Most of the men will have small means; most of what they have will be invested in homes in towns where only he can furnish employment; they will have no other possible employer but he in the trade which they know. After the backbone of the strike is broken; after it is seen that he does not mean to compromise, but to compel them to yield or go back to the status of day laborers, the men will perforce come flocking back again on his own terms. If he loses money temporarily by this persisting in a right or wrong position, he will gain it back partly by rise in prices and partly by subsequent increased demand. Besides this, his blood is up anyway. He "proposes to manage his own business in his own way," free from dictation of the men. He is both able and willing to stand a considerable loss rather than "submit to dictation." However able may be the manager, he will still be human, with human passions of undiminished force, but with largely increased power to gratify them.

His one need in this program will be protection against lawless violence; i. e., against attempts of the men to use their excess of physical force to abridge his legal right to control of his property, and "to select his own employees." The community will owe it to itself to give him this whether he was originally right or wrong. If he was right, it will owe it to him also. If he was wrong, the community will not owe it to him, but its necessary act for its own protection will nevertheless be aiding him in an act of perhaps cruel injustice. Naturally the men will think him wrong, whether he was or not. They will see the community's act, but not the necessity for the act. In about half the instances it will be likely that it will work practical injustice, and after a few such experiences it will be small wonder if many of the men should add to their hatred of the master a hatred of law and order also.

Now let us suppose that the men initiate the contest by striking:

The men may have been right or wrong in their original contention, but whether they be right or wrong, they will have absolutely no effective weapon to use against the master except physical force. He will be the only employer in their line in the town or city where they live, or in the country. Their little all is invested in homes which they must abandon as well as their trades, to find new employment. He will be in close relations to other trades at all related to their own. He can afford to wait while they cannot, and he can certainly replace them in the end, perhaps with a poorer force at better pay, but that will do no good to them unless they yield. He has no temptation to use force against them, and thus bring the law on their side. The law forbids them to use force against him. Nevertheless, their very sense of helplessness will then make them more bitter; their bitterness more unreasonable, and their unreason more ready to resort to violence.

Will these conditions be tolerable, and are they consistent with a high democratic civilization? Let every man think out the question for himself, but think it out "at the limit," under the magnified conditions we have assumed, and not using this morning's paper for facts to reason from.

Is the assumed limit a really possible one? Let us see. Already the vast steel rail industry has concentrated itself into the hands of five companies, between which the closest kind of a combination and understanding exists; viz., the Illinois, Carnegie, Harrisburg, Scranton and Bethlehem companies. They have for years maintained without a break the price of steel rails, far above the natural market price, while by a singular coincidence the price of steel billets, on which the wage scale depends, has been falling with exceptional rapidity. It is but a single and a short step further to consolidate these five companies into one company in form as they already are in fact, for many purposes. With absolute monopoly of the rail industry this company, if formed, would also have practical control of the other steel industries.

Already it has been urged by the President of the Illinois Central Railway and many others that our entire system of railways, which we have assumed to be divided up between three companies, shall be consolidated under a single management, as for the best interests of both the public and the stockholders, and certain to come anyway. There is not a single trade of any magnitude in which "trusts" or combinations of some kind do not exist, and as we have already said, they must and should exist if we are to have the cheapest possible production. It can hardly be denied that during the last half century we have traveled more than half-way toward such a concentration of industries as we have assumed as a limit. It is, therefore, not unreasonable to assume it for hypothetical purposes only, to test the possible effects of present industrial tendencies.

What remedies, if any, are indicated for such hypothetical conditions, and whether we are or are not now feeling the first effect of the approach of such conditions, we will not now discuss. The first and most essential step toward solving any difficulty is to grasp correctly its real nature. That first step alone we have sought to aid. It is the only one at present which we feel able to aid.

LETTERS TO THE EDITOR.

WEB SPLICES.

Sir: I am sorry that "O" in his communication of 18th inst. did not give us his opinion of the value of certain rivets, as I suggested. I am sure that the bridge men will agree with me that where splices are used, they should be on the pieces cut, and that there has not been as much attention paid to this as there should be. This is the only point I wish to make.

Respectfully, C. H. Wright.

Edge Moor, Del., Aug. 22, 1892.

(We cannot continue this discussion further.—Ed.)

DIMENSIONS OF A DREDGE BOAT'S HULL.

Sir: Will you allow us to call your attention to the fact, that in your account of the construction and performance of the dredge which we have lately built for the New Orleans & Northeastern R. R. Co., for filling in their Lake Pontchartrain trestle, you state the size of the dredge boat as 40 ft. by 40 ft? As a matter of fact, this boat is 40 ft. wide, by 86 ft. long, and as the measurements are misleading, and might create a wrong impression in the minds of people who have read the item, we trust you will make this correction. We remain, very truly yours, W. B. Crittenden,

Gen. Man., Bucyrus Steam Shovel & Dredge Co.

Bucyrus, O., Aug. 17, 1892.

(The above communication may serve to point a moral. The dimensions of the boat were printed exactly as they were given in the type-written description furnished us by the Bucyrus Company's engineer. If correspondents in furnishing matter for publication will read over whatever they send us as critically as they read the printed article when published, they will avoid errors similar to that noted above, and will confer a favor on both the publishers and readers of Engineering News.—Ed.)

HONDURAS INTEROCEANIC RAILWAY.

Sir: Please state in an early issue if the interesting news you reported from Honduras in your issue of Aug. 18 refers to Spanish Honduras. It makes all the difference in the world to a contractor who wants to be sure of his hard earned money. Respectfully,

Hale.

Nashville, Tenn.

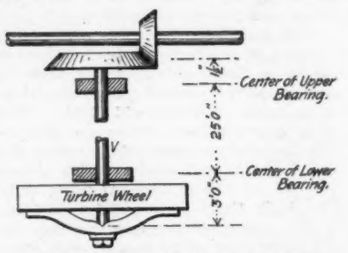
(A glance at an atlas would show our correspondent that as British Honduras only extends a short distance back from the east coast it cannot have an interoceanic railway. Honduras proper, the independent nation, has a little "one-horse" railway about 37 miles long from Puerto Cortes, on the east coast, to St. Jago. It is all that was built of an interoceanic railway projected some years ago by an English company. It is reported to be in a very dilapidated condition, and trains are run only once or twice a week. Several interoceanic railway projects for Honduras have been brought forward from time to time, but the local traffic would be small, and the Panama R. R. seems able to carry all the through traffic until the Nicaragua Canal shall be completed. The proposed Honduras North Coast Ry., which was projected by an American company, was described in our issue of June 16, 1888, but no construction work has yet been done.—Ed.)

SHAFTING AND PRIME MOVERS.

Sir: I inclose herewith a rough sketch of a turbine wheel fastened to a vertical shaft in the usual way, transmitting 65 HP. at 40 revs. per minute, by means of a mortise wheel and pinion to a horizontal main shaft.

I would ask you to kindly give an expression of your opinion in an early issue in regard to determining the strength for the above wrought iron solid shaft V from a rigidly scientific point of view, based on first principles. I find that in many cases of common practice the diameter of such a vertical shaft is obtained from the same formulas that are employed in making calculations for horizontal shafts, i. e., introducing as elements of calculation the torsional moment and the bending moment, which evidently will not meet the case at issue.

Another controversy that has arisen and upon which



Turbine Wheel on Vertical Shaft.

your opinion would be requested is, whether such a vertical wheel shaft, driven by a turbine wheel, would have to be considered as a "prime mover" or a "secondary mover," considering that the power is (not as the crank movement of an engine) a uniform force working on the shaft through the wheel. According to Prof. Rankin's statement (page 489, Mach. & Millwork) in such a case the shaft would have to be considered as a secondary mover. Sincerely yours,

W. Otto Gronen, M. E.

Rock Island, Ill., Aug. 24, 1892.

(We are in much the same state of mind over this problem as the gentleman from Calaveras County who "couldn't see no pints about that ar frog that was any better than any other man's frog." It seems to us a simple and ordinary case of a shaft subjected to torsional and bending moments. As a practical problem our candid advice would be to figure out its necessary proportions by the usual formulas and then make it a little bigger; but we recognize the interest and value of discussions of such points from a "rigidly scientific point of view," and if any of our readers, more competent than we, see scope for such a discussion we shall be pleased to publish it. As to whether the shaft is or is not a "prime mover," if our correspondent will remember that "prime mover" means simply "first cause of motion," he will not need to ask that question, which is one to be settled by a dictionary, not by a treatise on mechanics. If a man be riding horseback, which is his "prime mover"—the horse or the saddle? In a loose way we may speak of the horse and the saddle together as the "prime-mover" without danger of confusion, but when we come down to rigid exactitude the prime mover is only that which makes things move; not that which merely transmits.—Ed.)

RIGID TIE PLATE AND JOINT FASTENINGS.

Sir: I am very glad to note the editorial on my communication on the tie plate and joint fastening subject in your issue of Aug. 18, but I would beg to call your attention to an error in number one, of the two facts brought out as bearing on this question, wherein it is stated, "English track has always had the rail and the tie rigidly connected."

There is no English track laid in England, or by their standard, which we have used in this country, where the rail is rigidly connected so as to absolutely fasten the rail to the cross-tie, neither do I know of any track in the world which has ever been laid and in use long

enought to be recommended by any railroad company which absolutely fastens the rail to the cross-tie with an iron plate, forming a rigid iron fastening.

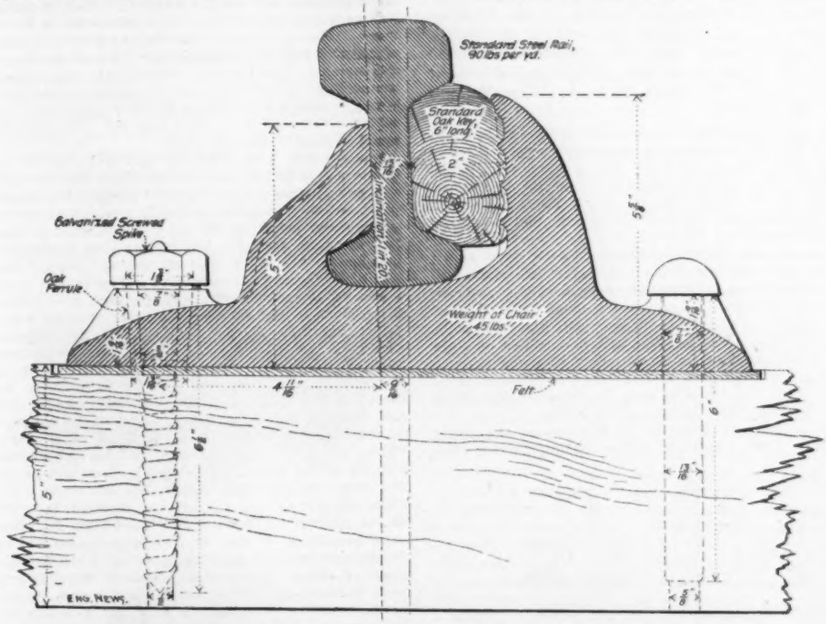
As an illustration I inclose you a print of the London & Northwestern Ry. standard track, several miles of which has been in use on the Pennsylvania Railroad system since 1888.

You will observe while the 45-lb. cast iron chair is absolutely fastened to a cross-tie, the rail is placed in an easy chair, wedged with a wooden block, or an iron spring, all of which gives exactly the same allowance, which I have endeavored to explain, and which will be eliminated when the rail and the tie are fastened absolutely together. Yours truly,

Joseph T. Richards,

Philadelphia, Aug. 24, 1892. Asst. Chief Eng. P. R. R.

(In a sense, perhaps, our correspondent was right, but it still seems to us that for all practical purposes we were right in stating that "English track has always had the rail and tie rigidly connected." Wherein is there any real lack of rigidity in the attachment shown? The connection between tie and chair is admitted to be absolutely rigid. The screw bolt and drift bolt have no "give" to them, and do not work loose, as do our smaller track spike. Is there any more give between the tie and chair? It is a question of fact. We do not believe there is. The oak block is generally most thoroughly seasoned, and expands when exposed to the weather. It is driven



RAIL AND CHAIR OF THE TRACK OF THE LONDON & NORTHWESTERN RY.

home with great force and beds into the serrations of the chair so that the block itself cannot possibly move up and down. On the other side the rail is fast against the lug of the chair. If there were the slightest relative movement of rail and chair the rail would not be long in working loose, in our judgment, but in good joints of this nature, in good condition, we apprehend that the most delicate tests would not show any more movement than would occur between the same two parts rigidly connected by bolts. The reason why this particular form of joint has found favor we judge is that it combines ease of making and unmaking with a certainty of rigidity; not that it permits any play. Moreover, rigid connections between metal ties and rails have been in extensive use for over 30 years, and their action subjected to most careful scrutiny. Has this particular point ever been brought up against them? When there is any real error of practice, as when the rails were fastened direct to a rock bed in the early days of railroading, experience soon reveals the error.—Ed.)

INTERPRETATION OF ROOF TRUSS SPECIFICATIONS.

Sir: Can you or any of your readers state what is the common practice in roof designing as regards the specification for a roof to carry a certain number of pounds per sq. ft.? Is it considered that the surface is to be measured along the inclined length of the rafter or on the horizontal projection of the same. The former has been my practice and seems to me the correct one. To illustrate, suppose to you as consulting engineer was submitted the design for a roof of 100-ft. span c to c, with trusses spaced 15 ft. c to c, and the requirement was that it be designed for a total load of 40 lbs. per sq. ft. Would you consider that the total load on one truss was (according to this specification) $100 \times 15 \times 40$ lbs., or would the proper load for the truss be instead represented by the product of 40 lbs. $\times 15 \times$ twice the length of inclined rafter)?

In a case like that submitted to me recently, in which the truss was figured for the smaller load, I maintained that the truss was not up to specifications, but was disputed in that decision by engineers quite as competent to judge as I am. Expressions of opinion on this point might be of interest to the general engineering public. Yours very truly, T.

Cleveland, O., Aug. 27, 1892.

(Wherever specifications are ambiguous, a disagreement among doctors may be expected. In our opinion a specification for a roof truss requiring it to be dimensioned for a load of 40 lbs. per sq. ft. should be taken to mean 40 lbs. per sq. ft. of exposed surface. A snow load may fall as deeply on a roof of moderate slope as on a level; and if the dead load of roof covering is included, that would naturally be computed by superficial area.

As for the wind pressure, if that is also included, it is not easy to see how anyone save the writer of the specification could tell whether inclined surface or projected area was the proper basis for it. Very naturally a contractor who had taken work under specifications worded as above stated, would insist on the interpretation stating the lighter loading. An engineer who had authority to do so would be apt to clip the Gordian knot by considering whether the lighter loading was sufficient for safety. If it were not, he should insist on the other interpretation.—Ed.)

MR. CHAS. S. STORROW AND THE LAWRENCE SCIENTIFIC SCHOOL.

Sir: As giving some information which is due perhaps to the oldest of our eminent early engineers still living, and which you may desire to use in revising for publication in book form your articles on the "Engineering Schools of the United States," it may be of interest for you to know that probably very much of the peculiar insight into the requirements for a successful engineering school shown in the letter of Mr. Abbott Lawrence transmitting his gift to Harvard University was due to his acquaintance and friendship with Mr. Chas. S. Storrow.

Mr. Storrow was, 50 years ago, probably the best educated engineer in America, and was in many ways one of the most remarkable men of his time. He was urged by Mr. Lawrence to take the general direction of the Lawrence Scientific School and to accept its professorship of engineering at the time when the school was first contemplated (1845 or '46). He was at that time actively engaged in planning the water power development at Lawrence, Mass., he being engineer, treasurer and general manager of the Essex Co., which had in 1844 purchased nearly 1,000 acres of farming land along the shores of the Merrimack at the point where the city of Lawrence now stands.

The Lawrence family were heavy stockholders and promoters of the enterprise, as may be judged from the fact that the new town was named after them. Mr. Storrow was himself a stockholder in the enterprise and a man of means; and as he told me, felt that he should enjoy himself better in the actual direction of a large engineering enterprise than he should to settle down into a professorship; and he has also told me that he consulted a great deal with Mr. Lawrence as to what was needed in the way of a school for engineers.

The result of these consultations and of their intimate association can, I believe, be very clearly seen in the letter of Mr. Lawrence.

As showing more clearly what kind of a man Mr. Storrow was, and is, I venture to call to your attention the fact that he was the author of the first connected treatise upon the science of hydraulics in the English language, so far as I can learn. I have a copy of this work of Mr. Storrow's and there is no book in my library which I prize more highly. It is entitled "A Treatise on Water-Works," published in 1835. I was looking it over again last evening and it is a most remarkable book, when one considers that it was written nearly 60 years ago. Engineering books of 50 or 60 years ago are generally rather meager affairs; but this, in the beauty of its analytical methods, and in the clearness in which the general matters are presented, will compare very favorably with the recent and admirable treatises of Merriman and Church, though of course the science has since grown.

This book was written by Mr. Storrow soon after his return from several years' study in probably the best engineering schools of France, whither he went after graduating from Harvard College in the famous class of 1829, along with such men as Benj. Pierce, Oliver Wendell Holmes, James Freeman Clarke, etc.

When speaking of engineering, there is an anecdote of Mr. Storrow's which is of interest: Channing, the famous divine, was an intimate friend of the Storrow family and shortly after Chas. S. Storrow had graduated from Harvard, Channing asked the young man what profession he proposed to follow. "Civil engineering," was the reply. "What is civil engineering?" queried Channing. Thereupon Mr. Storrow went on to describe the variety of information needed if one would be master of the profession; that he must be an accomplished mathematician, must understand masonry, machine design, the laws governing flowing water, the strength and properties of materials of construction, etc., etc. So he went on, full of zeal, stating what a man ought to know if he would be a civil engineer. Suddenly Channing stopped him and said "Hold on, Charles, you have already told me enough to convince me that no one man can ever become a civil engineer."

Mr. Storrow is still hale and hearty and if you care to pursue the matter of early technical education in America, in general, or the founding of the Lawrence Scientific School in particular, I have no doubt that he would cheerfully answer any of your inquiries. His address is 192 Beacon St., Boston.

There is one other point to which I wish to direct your attention in your revision of these articles, i. e., that of giving to Prof. Wm. B. Rogers credit which as I understand it is due him, for being the originator of the laboratory system of instructing students by placing the apparatus directly in their hands and leaving them to work out the problem by themselves, aided by the instructor only in helping them out of difficulties. Prof. Rogers' methods in this respect were a decided departure from the older methods of college instruction, in which the experiment was performed by the professor at his desk while a room full of students merely looked on as spectators. Prof. Pickering, who is now at the head of the Harvard Observatory, could give more information as to the credit due Prof. Rogers on this behalf than any one else whom I can now recall. He was Professor of Physics at the Massachusetts Institute of Technology, as you may recall, from the founding of the Rogers Physical Laboratory until called to take the direction of the Harvard Observatory.

In Prof. Pickering's treatise on Physical Manipulation the work is inscribed to Prof. Wm. B. Rogers as "The first to propose a physical laboratory."

Three years ago, when visiting physical laboratories at the polytechnic schools at Zurich and Berlin, I was very forcibly struck by the extent to which they were adhering to older methods of laboratory instruction; i. e., instruction by classes, all on the same experiment, rather than by placing apparatus in the hands of individuals and urging them to work out the problem independently of others. This latter method now obtains, I believe, in all American scientific schools, and for the introduction and early promotion of which great credit is due Prof. Rogers.

In the matter of the Lawrence Scientific School, I

think also that you should give more credit in your revised edition to the awakening which was brought about while Prof. Chaplin was dean of the school. The number of students, which had fallen to about 15, increased to about 120 during the half dozen years of Prof. Chaplin's connection with the school.

Very truly yours, John R. Freeman.

Boston, Mass., Aug. 15, 1892.

(We are greatly obliged to Mr. Freeman for the information in this letter. It explains what before was inexplicable without assigning to Mr. Abbott Lawrence truly remarkable mental qualities, how his letter of gift to Harvard College could have so accurately outlined the requirements of the day in regard to engineering education, and how to meet them.

We thought we had done as full justice as words could do to Prof. Rogers' work in founding the Massachusetts Institute of Technology, and especially in introducing improved methods of experimental instruction in physics and mechanics. Our correspondent perhaps overlooked what we said on this point.

We should have been glad to have recognized more fully Prof. Chaplin's zealous and persistent efforts to put new life into the Lawrence Scientific School, but (owing to obstacles for which Prof. Chaplin was not to blame) they were not crowned with anything like the success which our correspondent infers from the face of the returns. The pending more earnest reorganization, which we shall notice more fully later, will complete the work he aimed at, however, we trust.—Ed.)

A NEW PORTABLE BRIDGE.

A new portable bridge (see Eng. News, May 26, 1892), consisting of interchangeable parts, and easily put together by unskilled workmen, is described in the "Deutsche Bauzeitung," to which we are indebted for the following details and illustrations.

This type of bridge may be built with a maximum span of 111.5 ft., and with a width of 6½ ft., and is constructed to bear a uniform load of 30.7 lbs. per sq. ft. The material employed in its construction is steel, excepting the stringers and flooring, which are of wood. The structure has a height of 6½ ft. The floor-beams consist of I beams, and for the transverse braces flat straps are employed.

The bridge consists of five parts, as shown in Fig. 1, Part A is formed by the post resting on

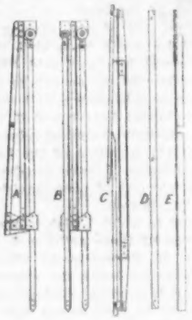


Fig. 1.

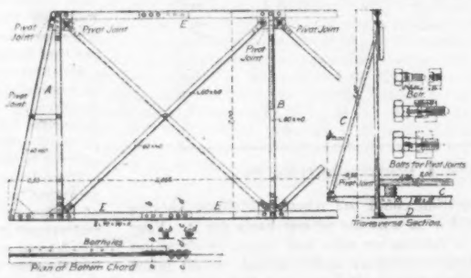


Fig. 2.

the abutment, and is connected with one strut and diagonal. The pivots are shown in Fig. 2. Part B consists of one strut with two diagonals connected; C is formed by the floor-beam, with two stiffening braces; D forms the transverse brace, and E is employed in the construction of the top and bottom chord. Fig. 1 shows the manner of folding the several parts, which are not to be taken apart. The bolts which are used in places where rivets can not be employed, are made of steel, and turned very evenly, and the bore of the bolt-holes is also very smooth. The pivot bolts have a diameter of 1 1-32 ins., and those used in top and bottom chords a diameter of 25-32 in. The rest of the bolts are ⅝ in. At the pivot joints for the diagonals heavy gusset-plates are used. The angles forming the top and bottom chords are each provided at one end with two plates riveted to them for the purpose of making a joint, as shown in Fig. 2. The manner of connecting the floor-beams with the trusses is also plainly illustrated in this cut.

As already mentioned, bridges of different lengths of span may be constructed of these portable sections. The smallest span possible is 19.7 ft. As necessity arises the length may be increased by adding one or more panels, each panel being 6.5 ft. long. An extension truss of 57½ ft. long, consisting of parts similar to those described, is employed for the purpose of putting the truss into its final position. The bolt holes shown in Plan E, Fig. 2, are to receive the bolts for the purpose of fastening the overlapping parts of the extension truss to the bridge proper. If during erection the bridge is pushed along so far as to overhang the river to be crossed about 72 ft., a counterweight of 7,495.7 lbs. is required to hold down the other end. For this purpose a part of the wooden flooring and stringers of the bridge may be employed, as their total weight aggregates 9,480 lbs. This counterweight is removed as soon as the end of the extension truss rests on the rollers on the opposite shore.

The weight of the bridge proper is 11,243 lbs., that of the extension truss 5,732 lbs., and the rollers used have a weight of 2,160 lbs. The total weight, therefore, amounts to 19,134 lbs.

TIN IN SOUTH DAKOTA.

So much has been published concerning the South Dakota tin deposits, both in the way of extravagant praise and wholesale condemnation, that the public hardly knows what to think concerning them. Mr. Stephen H. Emmens, President of the Emmens Metal Co., of Youngwood, Pa., and the inventor of the new explosive Emmensite, publishes the following careful and apparently unprejudiced statement concerning South Dakota tin in the "Financial and Mining Record:"

In the year 1888 I was requested by the late Mr. S. J. Randall to prepare a memorandum upon the subject of the tin mines of the United States, and in the course of my investigations I personally visited the principal tin localities in the Black Hills. Since then I have read with frequent amusement, and sometimes with amazement, the many strange stories that have appeared in the newspapers respecting the development of the tin industry in South Dakota. The matter is, undoubtedly, one of national importance; but inasmuch as success cannot be achieved without the assistance of capital, it is difficult to appreciate the wisdom of writers who have thus indulged in a series of fairy tales calculated to discourage every capitalist of common sense from even looking into the business. Perhaps, then, the following plain statement of plain facts may prove of some present public service.

There are two principal tin districts in the Black Hills, namely, a northern and a southern district. The northern district is situated at Nigger Hill and Bear Gulch near the line between South Dakota and Wyoming in the northwestern part of the Black Hills. The southern district occupies the flanks of the Harney Peak range, circling round from Harney City on the east to Custer City on the southwest. I visited both districts and in each was gravely assured by the local miners, claim owners and boomers that the other district had no tin of any value. For example, at Deadwood, Spearfish and Bear Gulch, I was told that the Harney Peak people had surreptitiously obtained tin ore from the northern district and had then sent it to New York and London as coming from the southern mines. On the other hand, at Rapid City, Hill City and Custer, I was assured that the Nigger Hill people had salted their samples with ores obtained from the mines near Harney Peak. But the truth is that both of the districts are tin-bearing and capable of producing satisfactory samples. I do not mean to say that the two districts are equally rich; for in the stage of development that existed in 1888, the southern tin-field was clearly ahead of its northern competitor, and no discoveries have since been made to alter the comparison. In view, however, of the frequently published statements that the great Harney Peak Co. have a virtual monopoly of the tin mines in the Black Hills, it were well to bear in mind that considerable deposits of tin ore exist in a district (Nigger Hill and Bear Gulch) lying quite outside their numerous claims.

As regards the character, magnitude and probable future of the tin mines in the two districts, it may be broadly stated that the quantity of tin ore in the aggregate is very large and the quality very satisfactory. I have mined tin in Cornwall and am familiar with the mines of that famous field; I do not, therefore, speak at random when I say there is a better show of tin in the Black Hills than in Cornwall. This, however, is very different from asserting the probability of any mines being developed in the Black Hills to rival the larger tin mines of Cornwall. The geological features of the two countries are very different. The veins are unlike. A great dissimilarity is observable in the modes of occurrence of the cassiterite itself. Space does not admit of my entering into any detailed scientific discussion of these and many other features of difference; but I am quite sure that no expert miner, geologist or mineralogist who has personally inspected the tin mines of the Black Hills and Cornwall will care to place himself on record as seriously looking forward to the development of a Dolcoath in South Dakota.

Take, for example, the report made by Prof. Vincent. Soon after the controversy that led to the withdrawal of the Harney Peak Co.'s prospectus from the London market, Prof. Vincent was employed to make an exhaustive investigation of the company's mines. It was hoped that he would find himself able to substantiate the glowing statements of the prospectus; but when his voluminous and careful report at length appeared, its conclusions were found in utter opposition to the extravagant anticipations with which the newspaper press of America and England had been deluged. In face of this very hard fact, I cannot believe that the preposterous nonsense recently put into the mouth of Lord Thurlow by professed interviewers was ever uttered by that nobleman who enjoys a well deserved reputation for sound sense and business ability.

Another very hard and very significant fact is the failure as yet of any mine in the Black Hills to make a regular output of tin for the market. The public is led to believe that this failure is a matter of shrewd purpose and policy on the part of the Harney Peak Co., who have wished to buy up the whole of the good tin mines in the Black Hills at moderate prices before starting a "boom" and putting up values against themselves. This explanation might, perhaps, pass muster if the production of tin depended solely upon the action or inaction of the Harney Peak Co. But it so happens that there have been other Richmonds in the field. Have New Yorkers forgotten the display of ingots of tin in a Broadway window (in 1888 I think) by the Cleveland Tin Mining Co.? Do they not remember that this company claimed to have a vast and rich tin mine in the Nigger Hill district of the Black Hills? Have Chicagoans forgotten that many reputable and wealthy citizens of the Lake City erected a large mill at the Tin Mountain mine near Custer City and made a vigorous attempt to send tin into the market? Is it not in the memory of the people of Scranton, Pa., that some gentlemen of that city, of large means and of the highest business standing, acquired a considerable group of claims in the neighborhood of Hill City and were anxious and willing to mine and reduce tin ore for the market? Was not the Etta mill a serious enterprise, and did not those persons who paid for it and commenced actual mining and reduction upon a very large scale intend to continue working? And cannot the residents of Spearfish, Deadwood, Rapid City, Hill City and Custer City point to many other genuine, spirited and honest attempts to produce tin in the Black Hills?

A general result has usually some general cause. An individual mine may be good in itself but may fail through mismanagement. An individual company may lock up its properties and refrain from entering the market by reason of some special policy. But when we find every developed mine and every operated mill brought to a standstill and every company keeping out of the market for years, and when, moreover, we find the residents of the districts taking up and selling claims but never working them, we may reasonably infer that some general condition exists which adversely affects the prospects of commercial success. I called attention to this view of the case when I was at Rapid City. I pointed out that the most satisfactory evidence of a rich tin region existing in the Black Hills would be the actual and continuous shipments of tin; and, moreover, that the establishment of a customs mill would enable this evidence to be offered while at the same time, by providing a cash market for ore, it would enable prospectors and claim-holders, even if they were poor men, to work their properties. I stated the cost of the enterprise at $10,000, a figure which was subsequently confirmed by Messrs. Fraser and Chalmers, and I deposited $1,000 in a Rapid City bank as my subscription to the business in the event of the remaining $9,000 being subscribed by local residents. My offer met with no response, and after some months of waiting, withdrawing my deposit, I naturally deduced two inferences; first, that in the opinion of

Black Hills people, the sale of claims was decidedly more profitable than the working of them; and, secondly, that in the opinion of Black Hills people, grave doubts existed as to the continuous character of the ore deposits.

Is this, indeed, the key to the whole mystery? There is, as I have already said, a magnificent show of tin in the Black Hills and the aggregate quantity is very large. But I did not see and have not yet heard of any single mine in which any demonstration exists of considerable ore bodies. The famous Etta mine was a famous failure, and when I saw it in 1888, to use the Cornish miners' phrase it was "as poor as death." The cause of the stoppage of the mill was self-evident. And may not the cause of the delay of the Harney Peak Company in placing tin upon the market be also regarded as self-evident?

In conclusion, let me state that I share the opinion of Prof. Vincent and, indeed, so far as I know, of every well-informed expert of sober judgment who has inspected and reported upon the tin mines of South Dakota, namely, that the mines in question are for the most part capable of moderate production and moderate profits if operated with skill and economy, and if aided by the establishment of reduction works at various centers.

A NEW JOINT FOR GAS PIPE.

This pipe joint is specially adapted for conduits in soft ground and on river bottoms, where by the settling of the ground the usual lead calking becomes loosened, thereby causing leakage. It can also be used for conduits for water, compressed air and steam, as the tightening material used is not affected by these agents. The following descriptions and illustrations are taken from the "Journal fuer Gasbeleuchtung und Wasserversorgung." Fig. 1 represents a longitudinal section of a complete connection. The ring (a) of Para rubber is first inserted into the bell shaped mouth of the pipe, and then the two projections or noses (c) of pipe (b) are inserted through the opening (d), (Fig. 2), into the chamber. Larger

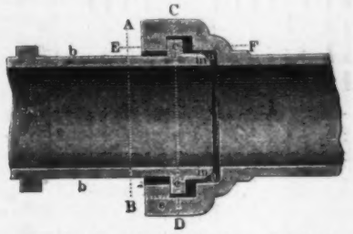


Fig. 2. Longitudinal Section of Joint.

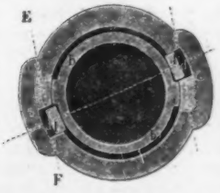


Fig. 2. Section AB.

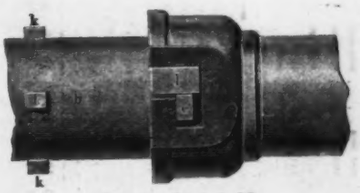


Fig. 3. Section EF.

sizes of pipe are provided with four or five corresponding projections. The joining of the pipes is then effected by tongs specially constructed to engage with the projections (k), shown in Fig. 3, and make the connection by a spiral movement of the joint. To prevent the pipe from turning back the wedge (l) is inserted. The end (m) of pipe (b) is conically shaped, in order to secure tightness at the sides. It is asserted that with this joint two unskilled workmen are able to lay from three to four times as much pipe as with the old devices. The new joint was subjected to a pressure of 15 atmospheres in a pipe line of 3 15-16 ins. diameter, and no leakage of any kind was noticed. Then the joint was lowered from 7.9 ins. to 9.8 ins. below the axis of the pipe line, in a length of conduit of 9.8 ft. During these two tests the two pipe lengths were taken apart and joined again four times, but the rubber ring was found to be intact in every case.

The inventor of this pipe joint is Mr. A. Hinden, Technical Manager of the Municipal Gas Works, at Neustadt, Germany.

ELECTRIC LIGHTING IN ENGLAND

It is well known that electric lighting is in a very backward condition in England, and, according to an article by Mr. H. Scholey, in the "Electrical Engineer," this is largely due to the want of action on the part of the municipal authorities, and to their objecting to permit companies to do what they are not willing to do themselves. On the other hand, people are rather slow in using this light, either for stores or houses, which accounts to some extent for the slowness of action on the part of the authorities, and, as shown in the article, which we reprint below, the financial prospects of the English electric light companies are not very promising. Details of the cost of electric lighting in England were given in our issue of Sept. 12, 1891. The difference from the present practice in this country is very marked, as in all our important cities and towns electric lighting, on the arc or incandescent systems, or both, is considered a matter of course, while it is in use to an enormous extent in the smaller towns, and no new town with any pretensions to a "boom" can get along without it. The question of municipal ownership is a disputed one, but the majority of the plants are owned by local companies; the plant and equipment being supplied by a comparatively small number of companies, which have grown by the consolidation of and acquisition of many smaller supply companies. Particulars of the plant of one of the London companies were given in our issue of April 28, and the cost of operation of the municipal plant at Topeka, Kan., was given in our issue of July 16.

It was expected that last year would have seen in England a large increase in electric light generating stations, but such expectations were not realized, for outside the metropolis there was scarce any attempt to undertake a public supply of electricity. The progress that has been made during the last twelve months has been for the most part confined to London, where there has been a quiet but none the less remarkable development of electric lighting business. There is scarcely an important street in London in which electric light cables are not already laid, and in many places a supply of electricity has been running uninterruptedly for many months. But the larger companies must make many more lamp connections before they run their stations economically; judging from appearances, however, this consummation will be soon reached.

Having regard to all circumstances, it is yet too early to expect London companies to show much profit, and, with the exception of the St. James Co., only nominal dividends have been declared. There is great praise due to the electric light companies for the manner in which they have pushed on their work, but it is to be feared that some of them will have an up-hill struggle before they stand on a firm commercial foundation. They may prove scientifically the correctness of certain theories, but electric light companies will only be deemed successful in London according to the size of the dividends they may earn. Electric light companies again, like other commercial concerns, are governed solely by the law of supply and demand. At the present price of electricity, the most remunerative customers are the clubs, shops, and theatres, and it seems most probable that the companies which were formed to supply purely residential districts will not make great profits. The householder who takes the electric light knows that it costs him much more than gas; he is therefore sparing in its use. For this reason it may happen that his electric light bill is no bigger than his old gas bills; but while this is very satisfactory from the consumer's point of view, it is more than doubtful from that of the supply companies. It is difficult to obtain figures as to the increase of lamps, but it would not be an exaggeration to say that there are nearly three times as many lamps burning in London at the present moment as there were last year.

A curious fact in the extension of the electric light is that the large provincial towns have practically done nothing. The smaller towns, in some cases villages, have shown greater appreciation of the advantages of electric light. This may be in a great measure owing to the action, or rather want of action, of the municipal bodies throughout the country.

The inquiry made by the Board of Trade in 1880 into the various schemes for the electric lighting of London did much to stimulate in the minds of the public a desire for the electric light; there was then displayed great eagerness on the part of the municipal bodies and joint stock companies to secure provisional orders which would enable them to start a public supply. The Board of Trade, having prominently in mind the burdensome results of gas and water monopolies, encouraged municipal authorities to undertake the supply of electricity; this encouragement, together with an exaggerated notion of the value of a provisional order for electric lighting, led many town authorities to take the necessary powers. Since 1888 over 120 provisional orders have been granted; of these 78 are in possession of local authorities and 37 are owned by companies. Of the 78 orders obtained by municipal authorities, not one has been proceeded with; they are for the most part shelved. There are perhaps, at the outside, four cases where it has been decided to build central stations. Throughout the whole of the country, there are only two central stations worked by municipal authorities, Bradford and St. Pancras (London), powers for which were obtained in 1882.

The work carried out by the companies under their provisional orders shows most favorably when compared with the municipal bodies, for under 37 orders 22 generating stations have been built and are working; were it not that local restrictions of an onerous nature had been imposed, the number would have been much higher. These facts on the face of them are significant, and the advocates of joint stock enterprises are at no loss for arguments in favor of electric lighting work being carried out by companies. It cannot be denied that local authorities have shown little regard to their duties under their orders, but I believe this apathy is mostly due to the fact that they never intended to supply electricity. Municipal authorities opposed companies entering their districts, because it was thought they could make a handsome bargain by offering the concession to a company, with special provisions for their own advantage. A glaring instance of this trafficking occurred recently when a provisional order was sold by a municipal authority to a company for £7,500. Electric light companies have been well tied down by Parliament, and to be forced to buy provisional orders will not enhance their future prosperity. However, it will be found perhaps that the municipal authority has entered upon a mistaken policy.

There is no doubt that the shelving of electric light orders by municipal bodies has had a most deterrent effect on the progress of electric lighting, for it is clearly shown that had these orders been in the possession of companies a good deal would have been done. At the same time there is perhaps something to be said on behalf of the municipal authorities not undertaking lighting, for it may be claimed that until quite recently there was no instance of municipal work to guide them; it is only within the last few months that the stations of the corporations of Bradford and St. Pancras were able to show a return on the money sunk.

The Board of Trade has power to revoke a provisional order, if at the end of two years it is found that compulsory works have not been carried out. Now, as many of these orders had been in existence two years at the end of June, 1892, a firm attitude on the part of the Board of Trade, together with the good results obtained at Bradford and St. Pancras, will do much to press forward electrical matters. At the same time it is not to be expected that the Board of Trade will act hastily in the matter, for there are many districts for which provisional orders have been obtained, which could not give a fair return on an electric lighting station.

It is an open question who can best supply the electric light; certainly a municipal body with its grip of local wants, and an organized staff at its command, holds a strong position; but the danger will be in selecting a system best adapted to its requirements. The instance of Bradford successfully carrying out a system of low tension is very well as far as it goes, but when they speak of supplying the whole of the town, five miles by three, with a feeder system, it seems as if there were matter for serious consideration.

On the other hand a company brings usually an accumulated experience without which no town lighting can be well carried out. To sum up, electric lighting in London may be considered to be rapidly advancing, but in the country, generally, much remains to be done before there is a good public supply.

A house-to-house inspection of water fixtures has been begun in connection with the water-works at Albany, N. Y. When fixtures are found in need of repair, it is stated that notice is given that the repairs must be made inside of 24 hours or else the water will be shut off. In addition to the desire to prevent waste it appears that all plumbers do not report new fixtures to the water department, as the law or city ordinances requires, and that some water is used without being paid for.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XX.

REQUIREMENTS FOR ADMISSION.

Any attempt to investigate this subject with any approach to accuracy is beset with difficulties. So much more depends upon the stringency of the examination than upon the number of alleged subjects for examination that a bare enumeration of the latter is of little value as an index of the amount of previous study and "general culture," which is required for entrance. For example, the U. S. Military Academy at West Point has nominally the lowest requirements for admission, demanding nothing more than the ordinary English branches of common school education and the history of the United States, yet it has a far larger percentage of rejected candidates than any engineering school in the United States, and its course practically requires that a youth of ordinary gifts shall enter with some knowledge of algebra and geometry at least, or with such thorough mental training as to make his progress in beginning those studies rapid. Similarly our oldest engineering school, Rensselaer, which certainly ranks high upon the list in the acquirements of its graduates, has only three subjects in which it examines for admission, the common English branches, algebra, through quadratics, and plane geometry. It will be seen below that quite a number of other scientific schools are very moderate in the number of separate subjects required for examination, while a number of the minor schools, which are by no means famous for the high grade of their instruction, have quite a long and varied list. In general, however, the requirements for admission should be a pretty fair index of the relative amount of prior mental training required.

Even to prepare a correct list of the nominal requirements of the several colleges is a task of great difficulty. We make an attempt at it in Table XIX., giving with all possible accuracy the nominal requirements at 56 colleges. The dozen or twenty others which we might have added to the list have somewhat lower, but not materially different requirements.

The difficulty of securing accuracy arises chiefly from the varying terms in which the requirements are stated in the catalogue, to which we have had to refer in nearly every instance, owing to the frequent errors made on this head in the blanks filled out for us at each college. As to what was or was not "advanced," French or German, for instance, "or algebra complete" there were highly variable standards. Some of the professors claimed less than they should, from too high a standard; others claimed a very high standard which reference to the catalogue failed to substantiate. We shall be thankful for the correction of any errors which still remain, which can hardly affect the average much.

Combining together as "miscellaneous" a few exceptional subjects for examination, we given in Table XIX. 29 different subjects of examination, each of which is required for entering one or more of the 56 colleges listed. That most nearly universal, as might have been expected, is what we have bunched together as the "common English branches," or ordinary common school branches, which are required at 54 of the 56 colleges, the exceptions being more apparent than real. Both are Schools of Mines (Missouri and Michigan, Nos. 31 and 49) both of which examine in mathematics only, the Michigan school quite severely (one of the most so in the list), the Missouri school very leniently.

Out of the full list of 29 subjects there are only 13 in all which are required by so many as one-sixth of the 56 schools. These subjects, with the number of schools which require them and the per cent. which they form of the total, are as follows:

	No.	p. c.
1. The common school branches	54	97
2. Physical Geography	27½	49
3. English Literature	27	48
4. English History	22½	40
5. American History	45	80
6. Elementary French, German or both	French 15½	28
	German 11½	21
7. Algebra through Quadratics	46	82
8. Geometry, Plane	48	86
9. " Solid	24½	44
10. Elementary Physics	22	39
11. " Chemistry	12¾	22
12. " Botany	9¾	17
13. Trigonometry	9¾	16

It will be observed that there are only four subjects (common school branches, American history, algebra through quadratics and plane geometry),

TABLE XIX.—NOMINAL REQUIREMENTS FOR ADMISSION TO 56 ENGINEERING SCHOOLS.

(The black dash indicates the subjects which are required. The fraction ½ indicates that either this or some other subject indicated by ½ may be chosen. To determine just what was required was in some cases difficult, and hardly any two colleges agree exactly in the severity and range of the examination on any of these many subjects, or even agree with themselves from year to year the tendency being general to greater stringency yearly. The Troy school of Civil Engineering at Dartmouth (No. 28) is really a post-graduate course and only 2 years long. Yale and several others have a 3 years' course, but most of the colleges agree in having a 4 years' course, as will be seen by the table following:)

| | 1 Rens. | 2 Harv. | 3 Yale. | 4 Dartm. | 5 Union. | 6 U. Mich. | 7 Br. Pol. I. | 8 Pa. Mil. Ac. | 9 Columbia. | 10 Wash. & L. | 11 Mass. I. T. | 12 Lehigh. | 13 Univ. Va. | 14 Cornell C. E. | 15 Tufts. | 16 Univ. Ga. | 17 Lafayette. | 18 Wash. U. | 19 Univ. Vt. | 20 Kans. Ag. C. | 21 Worc. P. I. | 22 Ala. P. I. | 23 Me. Agr. C. | 24 Ia. Agr. C. | 25 Univ. Pa. | 26 Stevens. | 27 U. Wisc. | 28 Dart. (The). | 29 Swarth. | 30 Cornell, M. E. | 31 U. Mo. | 32 U. Cal. | 33 U. Kans. | 34 U. Minn. | 35 Rutgers. | 36 U. Ia. | 37 Corn. Col. Ia. | 38 U. Ill. | 39 U. Cinc. | 40 Princeton. | 41 Tex. Agr. C. | 42 U. Nebr. | 43 Colo. S. M. | 44 W. U. Pa. | 45 Pa. State C. | 46 Purdue. | 47 Rose P. I. | 48 U. Tex. | 49 Mich. M. M. | 50 Mich. A. C. | 51 Ga. S. Tech. | 52 Mont. S. U. | 53 Univ. City, N. Y. | 54 O. State U. | 55 State Col. Ky. | 56 Vanderbilt. | Total in all. |
|---|---|---

which so many as 50% of the schools agree in demanding, but 80% or more of the colleges demand each of these. Either French or German or (in 5 instances) both are demanded by 59% of the schools. Physical geography, English literature and history, solid geometry and elementary physics are demanded by 40 to 50%. The rest are all scattering. Chemistry, botany and physiology are demanded by 16 to 22%; trigonometry by only 16%.

The last is a most surprising fact, plainly indicating that engineering education is still in an embryonic and transition state. Algebra, geometry and trigonometry may be called the alphabet of engineering, or primary tools of the trade. Only a small fraction of the elaborate superstructures which have been built upon the foundations of these sciences are needed for practical work by any one not a professed mathematician, but the foundations themselves, the elements of these studies, are simple and easily taught and learned in any good high school, while a complete working mastery of them is necessary for the most successful practice of engineering. It is absurd to take up any of the time of a professional course in teaching the elements of trigonometry, or algebra, or geometry, when the time is all too short for getting the necessary practical knowledge of their use as applied to problems of practical engineering. Neither is it fair to put colleges which spend a good part of a four-years' course on high-school studies of this nature on a par with those which require it as a condition of admission.

In a way, therefore, the requirement of trigonometry for admission might be expected to constitute a fair dividing line between the colleges which are true professional schools and those which are only (more or less) glorified high schools. In a way it does so, but with exceptions on both sides. There are some of the poorer schools which require it, and several of very high standing which do not. These last should enlarge their requirements at an early date, in our judgment.

That so large a proportion of our engineering schools should not require any examination in physical geography, English literature or history, French, German or Latin or any of the other non-technical studies which constitute so much of the "general culture" of the student, and to which but little time is devoted in any of the college courses (as we shall see), is a most unfortunate fact. In this respect also we expect that time will bring a rapid change. In too many instances,—in a number of very prominent instances which we will not particularize,—the requirements for admission to the engineering courses seem to have been drawn up by the simple process of taking the requirements for admission to the classical course, striking out all the Greek and Latin from it, and letting the rest stand as the requirements for entering the scientific course, with or without the addition of a little extra work in some subject like solid geometry. As the classical work thus struck out has occupied about three-fourths of the candidate's time for the preceding six years, and as the requirements added seldom mean more than a few months' work, the effect is to make an injurious distinction between the amount of prior study required for entering upon the classical and scientific courses of study; a distinction for which there is the less excuse because the four years at the engineering school are the end of the student's studies, whereas the four years in the classical course merely bring him to the beginning of his professional studies.

It must be admitted on the other hand that the requirements for entering upon the professional courses of law, medicine and divinity are seldom very rigid, but they are usually so in this, at least, that they require two years or more greater age than for entering undergraduate or scientific courses, and at least as stringent an examination as to become a classical undergraduate, so that the same end is attained indirectly. On the other hand, in no single case, which we have discovered, are the requirements for the technical courses a fair equivalent in stringency for the requirements for the classical course. For example, let us take the requirements for admission to the several courses at Yale, where the requirements for the engineering courses ought to be especially thorough, as the course is only three years long, four years being the all but universal rule of the better class of engineering schools. For admission as a classical undergraduate there is required:

1. A pretty severe examination in Latin, of which an amount requiring about half as much study only is required to enter the Scientific School, even this last being the rare exception at other schools.

2. A tolerably severe examination in Greek, not required at all for the scientific courses.

3. Arithmetic, algebra and plane geometry, substantially as for the scientific courses.

4. Elementary French or German, not required at all for the scientific courses, and hence about a fair equivalent for the Latin required for the latter.

On the other hand, to balance this practical omission of all requirements as to Latin and Greek, the additional requirements for entering the Scientific School are only:

1. The common English branches, including grammar, spelling, composition, geography and history of the United States; which appear to be taken as a matter of course in entering the classical course, and are not made subjects of examination, though practically all the freshmen have been well drilled in them.

2. Solid and physical geometry.

3. Elementary trigonometry.

The contrast is obvious and conspicuous even in this case where the requirements for admission are comparatively stringent, though it may be questioned if they are so in comparison with the usual requirements for entering the sophomore year of the four-year courses of most engineering schools. When we further remember that only three years of study are added to this amount of preparation it is obvious that the respective courses are framed on the assumption that it takes much less study to learn all one needs to know in the engineering professions than in what we may call the "classicals," an assumption which we believe to be utterly unfounded in fact. We may note in passing that the minimum age for admission at Yale is only 15 years, all departments, though the usual rule at engineering schools is 16 years, and at some 17 years. For entering the law or medical schools 18 years is required. There are reasons in the nature of the respective professions why engineering students should enter and leave college earlier; there is vastly more employment for young aspirants, but we perceive no reason why the scientific undergraduate of 15 or 16 years of age should not be required to have had as thorough preliminary training as the classical undergraduate of the same age, in the same college. In few or no colleges is this as yet required.

The first 52 colleges of table XIX. are the same as those bearing corresponding numbers in Table XIV. (issue of Sept. 5), where it will be remembered that the colleges were arranged chronologically in order of first graduates. The last four colleges of table XIX. (Nos. 53 to 56) are not quite in this order, though all four belong in the last half of the table. It will be seen by a glance at Table XIX. that there is no discoverable tendency among the younger colleges to a lower standard of requirement for admission than among the older colleges; but both the younger and the older colleges seem, on the whole, to tend toward less rigid nominal requirements than those of medium age.

Repeating again the caution already given, that there is often a vast difference in the stringency of examinations, so that the number of alleged requirements for admission has far less significance than might be supposed, the following specification of the number of subjects in the list of Table XIX. on which candidates for admission are alleged to be examined at the several colleges, may be of interest:

Of the 29 studies required for admission listed in Table XIX.:

1. (No. 4) Thayer School of Dartmouth College (which is more properly a post-graduate school, although not that technically) has	19
1. (No. 34, Univ. of Minn.) has	16
1. (No. 37, Cornell College, Ia.,) has	15
2. (Nos. 9, 53, Columbia and University of City of N. Y.) have each	14
3. (Nos. 7, 26, 30; Brooklyn Pol. Inst., Stevens Inst. Tech., Univ. Ia.) have each	13
1. (No. 25; Univ. of Penn.) has	12
2. (Nos. 18, 42; Washington Univ., U. of Neb.) have	11
6. (Nos. 2, 6, 14, 27, 31, 33; Harvard, U. of Mich., Cornell U., C. E. course; U. Wis., Cornell U., M. E. course; U. Kan.) have each	10
4. (Nos. 29, 32, 39, 54; Swarthmore, U. Cal., U. Cinc., O. State Univ.) have each	9
6. (Nos. 8, 17, 35, 38, 40, 55; Penn. Mil. Ac., Lafayette, Rutgers, U. Ill., Princeton, State Col. Ky.) have each	8
5. (Nos 3, 19, 45, 48, 56; Yale, U. Va., Penn. State Col. U. Tex., Vanderbilt U.) have each	7
5. (Nos. 11, 23, 44, 46, 49; Mass. Inst. Tech., Mo. Agr. C., W. Univ. Pa., Purdue, Mich. Min. Sch.) have each	6
7. (Nos. 5, 12, 15, 20, 21, 28, 47; Union C., Lehigh, Tufts, Kans. Agr. C., Worc. Polyt. Inst., Dartmouth Chandler Sch.), Rose Polyt. Inst.) have each	5
4. (Nos. 10, 22, 24, 52; Wash. & L. U., Ala. Polyt. Inst., Ia. Agr. C., Montana Sch. M.) have each	4
4. (Nos. 1, 13, 16, 51; Rens. Polyt. Inst., U. Va., U. Ga., Ga. Sch. Tech.) have each	3
3. (Nos. 31, 43, 50; U. Mo., Colo. Sch. M., Mich. Agr. C.) have each	2
1. (No. 41; Tex. Agr. C.) has only	1
Average of 56 colleges	7.71

SAFE INSTALLATION OF ELECTRIC WIRES.

In the early days of electric lighting but little attention was paid to the placing of wires in the interior of buildings. People were so accustomed to carrying telegraph wires everywhere without a thought of danger that electric light wires with the flimsiest insulation were put up in the most dangerout situations. We published the rules for safe wiring of the National Electric Light Association in our issue of Oct. 3, 1891. In a recent number of the "Electrical World" Mr. C. T. Snedekor writes as follows concerning defective material and methods still in use:

It is evident that the foundation cornerstone of absolute safety against electric fires must start in insulation of electrical conductors. After making an exhaustive analysis of every insulated wire made in the United States, England, Germany and France, and with a knowledge of the manner in which they are made and handled, from the drawing of the copper to the finish of each and the uses for which they are designed, I find that on this fundamental point there hangs a tale. Not 50% of the wire that goes on the market to-day is fit to use. Many of our electric light wires are carried into storehouses containing valuable merchandise by a tar or wax covered wire, with the poorest braiding that the unskilled hand can do hidden from immediate view by the aid of wax used to give a finish under the polishing machine. Next we find the old underwriters' wire with its "white locks" crawling in because "it's cheap." One word for the underwriters' insulated wire for inside equipment. It has been, when properly made, the safest wire for inside work, but it has not the lasting qualities required for a number one wire.

We must have good insulation first; then the wiremen must handle the wires carefully, they must take time, do all their work honestly, all joints must be made and covered by a competent man, and, above all, a genuine electrician who knows how the work should be done should lay out the work and inspect it. As the wire enters the building it should go through a fireproof tube. If wire is laid through concreted spaces, the owner of the property had better pay a few dollars for lead pipe rather than suffer a loss.

I find that there is, with all the applications at hand, some cause for criticism yet with the management of the dynamo. Switches for electric light and power need as much attention as the switches of the railroads to prevent accident. Again, great reliance is placed on fuses, which in many instances are overestimated as to their capacity and safety. It is the anxious hope of insurance companies that a genuine fireproof and water-proof insulation will be found, that when properly put up can be relied upon.

My opinion is that there is absolute safety from electric fires if the conductor is sufficiently large for any required current; if the conductor is carefully covered with first-class seamless rubber insulation first, next to the wire, then a second covering over the rubber of a refractory element or compound, then carefully braided and handled in putting it in place, so that no abrasions are made, and if all joints are carefully insulated and all entrances and exits are through porcelain tubes. The day is not far distant when all wires will be lead incased for concealed work in buildings.

THE PRESENT STATUS OF THE STORAGE BATTERY SYSTEM ON STREET RAILWAYS.

In the August issue of the Franklin Institute Journal, Mr. Pedro G. Salom, gives some of the reasons why so promising a field in electrical engineering has as yet produced no adequate commercial results. These reasons are practically as follows:

In the first place, patent litigations, involving the whole subject of storage batteries and the claim to the fundamental principle upon which all forms of storage batteries are constructed, has had more than anything to do with rendering capital timid and in delaying any extended introduction and development of the system. This fundamental principle is the broad claim for the application of the active material to a conducting support, and the fixed ownership of the basis patents is a first requisite to commercial use and further improvement.

As to the definite knowledge gained by the trials and failures of this system, the author of the paper refers to extended experiments made in Indianapolis, New York, Birmingham, in England, and elsewhere. The highest life record for the battery, he says, is

that made on the Citizens' Passenger Railway, in Indianapolis, where a single set of 108 accumulators made over 6,000 miles under the most trying and unfavorable circumstances. Based upon this record, and assuming a 12,000-mile run, as two sets of accumulators are always employed, Mr. Salom figures the cost at 3.85 cts. per car-mile as follows

216 positive groups, at $2.50	$540.00
Credit 2,592 lbs. lead scraps, at 3 cts.	77.76
Cost for 12,000 miles	$462.24

As to power required, careful records kept upon the Fourth Avenue Line, in New York, show that the amount of energy consumed per car-mile is about 1½ EHP. hours; or, that after making a round trip of 11½ miles, it requires about 17 EHP. hours to replace the energy drawn from the batteries.

The trouble in reducing the weight of the storage battery is that the weight required is not according to the total amount of work to be done, but according to the rate at which this work is to be done. This much-sought after reduction of dead-load is made practically impossible by the fact that there must be a sufficient reserve surface of active material to meet the emergencies of starting the car, ascending steep grades, etc., which may increase the demand for power from an average rate of discharge of 30 amperes to a discharge of over 100 amperes. This is the trouble with all thick plate batteries where the amount of surface area exposed is small when compared with the weight of the battery.

The reports of the West End Road, in Boston, for May and June, 1891, show that the total cost of the overhead system was about 21 cts. per car-mile, as compared with about 25 cts. per car-mile for the horse system. The paper here quoted does not go at all deeply into the car-mile cost of the storage battery system, only instancing the somewhat limited experience on the Birmingham road. On this line, with five cars in use and a total run of 138,396 miles in one year, the total traction expenses per car-mile were 14.74 cts. as compared with 15.74 cts. for horse traction. The item of material in the storage battery record amounted to only 2.66 cts. per car-mile, and it may be assumed that this is almost entirely chargeable to the renewal of the batteries. These records in detail are as follows, with the value in English money:

Storage Battery Traction per Car-Mile.

Electric Haulage	Pence.	
Wages	2.60	
Fuel	1.66	
Stores	.73	
Water and lighting	.07	
Sundries	.09	5.15
Machinery, Material	.29	.29
Car repairs. Wages	.60	
Material	1.33	1.93
Total traction expenses		7.37d

Horse Traction per Car-Mile.

Wages	2.44	
Forage and bedding	3.72	
Veterinary and shoeing	.40	
Water and gas	.06	
Harness repairs	.16	
Stable utensils	.04	
Sundries	.08	
Renewals	.43	7.33
Repairs. Wages	.28	
Material	.26	.54
Total		7.87d

Mr. Salom then feels safe in saying that even if the storage battery system did cost 4 or 5 cts. per car-mile more than the trolley system, it could now supercede the horse system and by its collateral advantages, in many places, debar the consideration of any other electric system. The author properly says that the public are not interested in the cheapness of the motive power beyond a certain limit. What they are entitled to is a safe, reliable and unobjectionable method of transit, which is cheaper than horses, and in this wish of the public lies the future of the storage battery system.

THE AUSTIN DUMP WAGON.

Dump wagons are an important element in the handling of material excavated in grading, etc., and we illustrate this week a new form of wagon which

Fig. 1. Wagon in Position for Load.

THE AUSTIN DUMP WAGON.

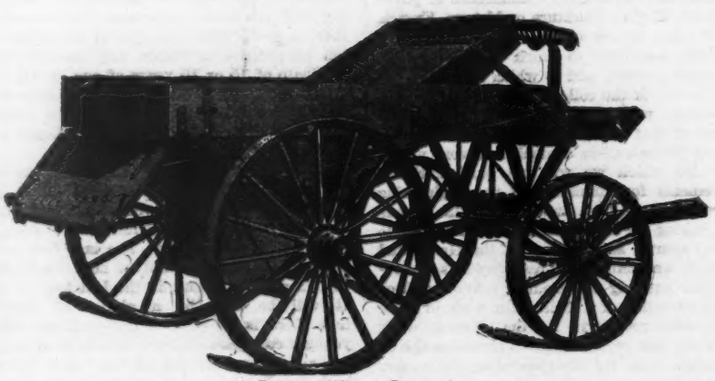


Fig. 2. Wagon Dumped.

THE AUSTIN DUMP WAGON.

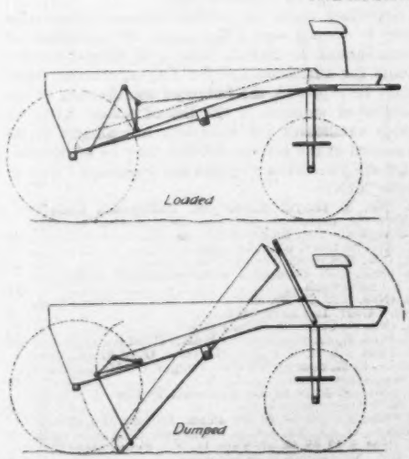


Fig. 3. Diagram Showing Mechanism of Austin Dump Wagon.

is claimed to be a great improvement upon the ordinary wooden wagons, and is suitable for any kind of soil or the carrying of any material requiring a quick dump. It is low, broad and short, and therefore easily loaded. It has broad tires, unusually easy draft, and has no reach or pole connecting the rear axle with the center bearing of the front axle, so that the wagon may be cramped short, drawn backward and dumped. The capacity is about 1½ cu. yds. The bottom is a heavy steel pan, hinged across the middle, and locked in position by pressing the long lever down into the jaw of the short foot lever. In dumping, the driver presses this short lever down, which throws up the long lever, releasing the lock. The rear end of the pan, being more heavily loaded, then falls down, shooting out the entire load. The rear axle is bent to allow of the drop of the bottom. Fig. 1 shows the wagon in position for loading, Fig. 2 shows the position when dumped, and Fig. 3 shows the position of the mechanism with the wagon loaded and dumped. The wagon is manufactured by the F. C. Austin Mfg. Co., of Chicago, Ill., makers of the New Era graders, scrapers, plows and other grading and earthwork plant.

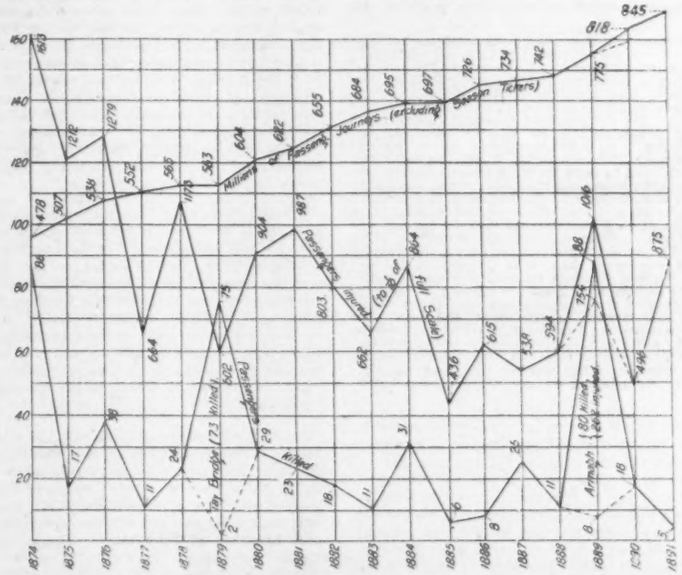
BRITISH RAILWAY ACCIDENTS IN 1891.

The general report of the Board of Trade on railway accidents in Great Britain and Ireland during 1891, shows a smaller number of passengers killed from causes beyond their own control than in any year on record. There were 845,463,638 passenger journeys (exclusive of season ticket holders), and only five passengers were killed in train accidents or one in 169,092,733. The best previous record was made in 1885 when the average was one passenger killed in 116,202,171 passenger journeys. As we have before pointed out, the passenger journey is a very misleading unit on which to base accident statistics, but passenger miles, which form the proper basis for comparison, are not reported in British railway statistics. To show the steady increase in safety of passenger travel in Great Britain we reproduce the diagram published in our issue of May 2, 1891, adding to it the figures for the last calendar year. It will be noted that injuries seem to decrease less rapidly than fatalities, but it is probable that this is largely due to a more perfect system of reporting accidents, and the inclusion of slight injuries, which in the earlier years were passed over as too trivial for notice.

Every serious railway accident which occurs in the United Kingdom, and many accidents which have no serious results but which are of importance from a technical standpoint, are "inquired into" by the railway department of the Board of Trade. From 1875 to 1884 the average number of accidents inquired into yearly was considerably over 100. Since that time the average has been about 60. A classification of the causes of the train accidents inquired into during 13 years is given in the accompanying table. It will be seen that in almost every one of the classes specified, the number of accidents is decreasing. The only exceptions to this seem to be the accidents due to trains entering stations at too high speed and the butting collisions. The former accidents seem to be mainly due to the inefficiency of English braking systems as compared with American. As a remedy for this class of accidents the Board of Trade are urging railways to forbid the use of the continuous brakes when entering terminal

stations, a recommendation which sounds strangely enough to Americans. The British railway managers are showing their good sense by generally opposing this rule; but three important companies have adopted it. Apparently the inspecting officers of the Board of Trade could learn something concerning good practice in the use of brakes by a study of American railways.

The accident during the year of greatest technical interest was the breakage of a lopsided cast-iron bridge girder on the London, Brighton & South Coast Ry. We commented upon it in our issue of July 4, 1891. As a result of this accident the Board of Trade has undertaken a systematic inquiry into existing railway bridges; and the returns, which



DEATHS AND INJURIES TO PASSENGERS ON BRITISH RAILWAYS FROM ACCIDENTS TO TRAINS FOR A PERIOD OF 18 YEARS, 1874-1891.

(Dotted lines for years 1879, 1889, show record with Tay Bridge and Armagh accidents excluded.)

promise to be decidedly interesting, will be published at an early date.

Accidents to Railway Trains Inquired into by the British Board of Trade from 1879 to 1891, classified by causes:

	'79.	'80.	'81.	'82.	'83.	'84.	'85.	'86.	'87.	'88.	'89.	'90.	'91.
Engines or vehicles meeting with obstructions, or leaving the rails in consequence of obstructions, or from defects in connection with the permanent way or works.	8	22	24	14	12	21	7	7	11	10	11	5	6
Boiler explosions, failures of axles, wheels, or tires, or from other defects in the rolling stock.	9	9	6	12	7	9	6	8	1	7	6	4	4
Trains entering stations at too great speed.	8	7	5	8	12	11	4	4	10	7	12	2	15
Collisions between engines and trains following one another on the same line of rails, excepting at junctions, stations, or sidings.	8	8	9	6	3	3	2	—	3	2	1	2	3
Collisions at junctions.	10	14	13	8	8	10	8	10	2	4	4	7	4
Collisions within fixed signals at stations or sidings.	43	49	36	48	44	40	24	25	22	16	25	24	25
Collisions between engines or trains meeting in opposite directions.	1	—	3	4	—	—	—	1	6	8	2	2	3
Collisions at level-crossings of two railways.	—	—	—	—	—	—	—	—	—	—	—	—	—
Engines or trains being wrongly run or turned into sidings, or otherwise through facing points.	9	8	9	12	6	11	7	4	3	4	4	5	4
On inclines.	3	1	6	—	2	—	2	3	—	1	4	2	4
Trains on fire.	—	—	—	1	—	—	—	—	—	—	—	—	—
Miscellaneous.	1	—	—	5	—	—	—	—	—	2	—	—	—
	100	118	111	118	94	105	60	62	58	61	60	53	68

STATISTICS OF THE WORLD'S SHIPWRECKS.

A recent number of "Engineering" reviews as follows the statistics of disasters at sea collected by Lloyd's:

We hear much of the many finely modeled ships that are built from time to time, but little of the many vessels that are lost. Occasionally public interest is excited by heroism displayed in saving a shipwrecked crew; but in many cases the loss of the good ship is only indicated by a line or two in the list of casualties in the daily papers. Who, for instance, would think that last year 68 vessels, the larger portion ships, sailed from some port or other, and, according to Lloyd's annual return, never again were heard of, and these too were fairly good-sized crafts. What of the crews? The story can never be completed, the sufferings may be but guessed at. And Britain and her colonies have more than their fair share, for while we make up a half of the total losses we contribute 28,500 out of the 49,100 tons which have thus passed out of record. The total of wrecks, too, seems large, 1,086 vessels of 649,946 tons, but it must be remembered that there are probably always afloat on the high seas over 20,000,000 tons of shipping, which fact, although it increases the surprise that so many vessels should be lost without any news, indicates generally a fairly low ratio of loss, 3 to 4% of tonnage. It may be accepted as a testimony in favor of steel that of the total tonnage lost only 12% was constructed of this metal, while 40% was of iron and 47% was wood and composite vessels. But it should also be noted that the iron and wooden vessels generally are older, so that age as well as material may have contributed to the result. Again, ships built more largely than steamers, the latter making 43% and ships 57% of the total; but age again must be considered. for a large number (124 vessels of 47,810 tons) were condemned and broken up against only 18,635 tons of steamers. A ship is more readily abandoned at sea than a steamer, because when the masts "go by the board" in a storm the ship is often helpless. We have therefore 50,570 tons of ships thus abandoned against only 9,000 of steamers, which latter in itself is a large number; they were all of large size too, averaging 1,200 tons. It is interesting to note further that steamers collide more frequently than ships, or the results are more disastrous. Thus we find that while 45,076 tons of steamers were lost by collision, only 12,849 tons of ship losses are so accounted for. The number of vessels does not show the same disparity, 43 of the former against 47 of the latter, which would indicate that small ships more readily collide, and one may be pardoned the assumption that these are mostly in home channels rather than on the high seas. Of course the hidden rock, the fog-bedimmed rugged headland and the overpowering tempest, are as disastrous to the steamer as to the ship, and we find that in each case about half of the losses are attributed to these more or less unavoidable causes. As to nationality, we find that the "death rate" of tonnage of Britain's fleet is 2.67%, and of the Colonies 3.13%. The highest rate is attained by Norway, with 5.24%; Russia being next with 3.49%, and Sweden with 3.35%, while the lowest rate is Spain, with 1.05%. The sailing ship owning States come highest. Britain has a heavier loss in ships than steamers, 3.90% of the former against 2.30% of the latter, her total losses for the year being 315 vessels, of 282,912 tons.

The consumption of brick in New York city has been considerably affected by the substitution of steel and iron construction, with walls in some instances, carried on the frame for the old style solid masonry walls. During the first quarter of 1892, permits were issued by the New York City Building Bureau, for the erection of 840 buildings, estimated to cost $15,764,048, an increase of 165 buildings, and nearly $3,000,000 in their value, over the corresponding period in 1891. Notwithstanding this large increase in building operations, the market for brick showed no improvement. As a correspondent of the "Clay Worker" says: "The architect that evolved the idea of the skeleton frame to the displacement of brick, need not look for a costly shaft to his memory from the brickmakers."

For "deadening floors" Gen. Loyre suggests the use of wood shavings, made incombustible by dipping them in a tub of whitewash or cement. Soft substances, including air-spaces, make an excellent non-conducting material to sound, and the saving in weight is important. A preliminary dipping in chloride of lime will disinfect the space between the boarding and the plastering. Mineral wool is much better, even if more expensive, and has the added value of positively excluding rats.

Single channel or auxiliary outlets has long been a subject of controversy among the residents of the Lower Mississippi Valley, who are vitally interested in the control of its floods. The judgment of most engineers, however, has been in favor of the restriction of the flow to a single channel. It is evidence that the question is not yet considered settled by those most directly interested, however, that a meeting was held at Moreauville, Avoyelles Parish, La., recently to protest against the obstruction of the Atchafalaya outlet. Resolutions were adopted, declaring that the obstruction of this outlet had resulted in grievous injury to the interests of the Ouachita, Tensas and Red River valleys, and was a standing menace to the people of the Lower Mississippi. Without these obstructions, it was contended that the Mississippi would be relieved of the flood waters of the Red, Ouchita and Tensas rivers. It was resolved to appeal to the Government to remove the obstructions, or else pay a fair sum to the owners of the lands affected.

The improvement of the Trinity River (Tex.), by the Trinity River Navigation Co., was authorized by a law passed at the last session of Congress. The law empowers the company to improve the Trinity River from Liberty to Dallas, about 300 miles, so that it will be navigable for vessels with a draft of not less than 3 ft. The company must begin work within two years, and continue as expeditiously as possible to the final completion. The United States reserves the right to take charge of the river and works at any time, on payment to the company of the original cost of the works, or their actual value at the time they are taken.

Cables on the street railways of Los Angeles, Cal., are long lived according to the "Street Railway Gazette," which gives the following table of the mileage life of cables on various lines:

Name of line.	Length of cable. ft.	Days in service.	Miles run.
Los Angeles, Grand Ave.	23,400	1,026	163 944
Denver Tramway Co.	24,000	605	144,000
Denver Tramway Co.	22,000	575	137,240
Kansas City, Grand Ave.	18,000	695	135,872
Los Angeles, Temple St.	12,380	700	120 681
San Francisco, Geary St.	13,000	605	119,153
Kansas City, Metropolitan	15,000	575	102,359

The cause of the long life of the Los Angeles Grand Avenue cable is partly the fact that the road has only one very easy curve, but it is stated that the cable is made with a harder core than is commonly used. It is made up of 114 wires arranged in six strands which are laid on a hemp core. The cable was made by the Hazard Mfg. Co., of Wilkesbarre, Pa., and the cost is given as $6,000.

Notwithstanding its long life, the cable is not yet worn out. It was removed on July 2, when it had made the mileage recorded above, partly on account of a defective place, and partly because it was desired to have an unworn cable to haul the heavy loads of July 4. It is stated that after repairing the defective portion the cable was to be replaced, and it was expected to do service for four or five months longer.

Permission to lay steam heating pipe in Cleveland, to connect with four large buildings, has been granted to W. W. Williams. The steam and return water pipes must not be more than 5 ins. in diameter, and must be provided with expansion elbows where necessary. All the work connected with laying the pipe will be under the direction of the Board of Control, and the Director of Public Works. The Board of Control may at any time order changes in the grade, location and construction of the pipes, and may also order their removal.

"Sand cement" is described by the "Engineer" as hydraulic cement, mixed with fixed proportions of sand, gravel or ballast, and finely ground. This composition is said to form an efficient mortar when mixed with sand, in the same manner as undiluted cement.

the grinding causing the cement to be distributed very evenly throughout the mass, and to coat the sand particles more perfectly. A dilution of as much as 16 parts sand to 1 of cement is said to be possible without unduly impairing the adhesive properties of the cement.

An international dam across the Rio Grande, five miles below El Paso, Tex., is reported as projected by a company incorporated with an authorized capital of $10,000,000. Mr. Wm. Hamilton, New York, is said to be at the head of the project. The dam, as proposed, will be 500 ft. long, 70 ft. high, of masonry on a solid limestone formation. Col. Edson Mills, of the U. S. Corps of Engineers, is reported as saying that the dam will cost $300,000, and the dam with all appurtenances for irrigation is estimated to cost $2,500,000. Water will be taken from the dam down both the Mexican and American side of the river.

An alternating current harpoon, for whale-killing, is described in the London "Electrical Engineer," as the latest electrical novelty.

A Chicago dry-dock is said to be now about ready for contract, which would be 450 ft. long, 125 ft. wide and 30 ft. deep. No particulars are yet given.

A gigantic drainage scheme is now being pushed by Mr. S. A. Jones, President of the Tampa Board of Trade. Mr. Jones says that it is proposed by New York capitalists to drain a tract of land 82 miles long and from 8 to 12 miles wide along the St. John and Indian rivers, at a cost of $4,000,000. This territory when properly drained would be available for sugar producing, as the muck is 3 ft. deep all over it.

Chinese railway building is expensive work, even at 10 cts. per day paid for common labor. Consul Gardiner describes the building of a 17-mile line now being constructed to bring coal and iron from the Wang-Shan-Shih mines. Work had been going on 8 months and the road will be finished in 3 or 4 months more. The work is costing more than it would in England owing to the poor physique of the laborers. A barrow that a European could easily trundle full, is only half-filled and it takes two Chinamen to push it at a very slow speed with many stops for rest. To humor the people land is bought at $300 per acre, or more than twice its value. Cut limestone for bridges and culverts is very expensive and the expense of breaking stone for ballast is so great that iron ore is being used. The rails and metal ties all come from Germany, and the Engineer is Mr. Schweidtweiller, an ex-attache of the German Legation at Pekin.

A system of 46 range lights has been established between Defour Passage and Sault Ste. Marie, in St. Mary's River, by the United States and Canadian Governments, eight of the lights being put in by the latter. The lights are chiefly for the benefit of heavy-draft boats.

The drainage and sewerage of New Orleans, La., seems at last likely to be carried out under the present contract with Capt. A. A. Woods. The problem is a serious one, owing to the almost dead level of the city, and the fact that the present surface soil is much fouled by the past very defective sewerage. As near as can now be learned, the present plan includes light pipes laid about 2 ft. below the surface, connecting with flushing tanks, and leading to wells 26 ft. deep, by 20 ft. in diameter. Powerful pumps will lift the sewage from these wells, and discharge it well out into the current of the Mississippi River. The company is also required to lay a system of drainage pipes for removing the subsoil water from the streets. The estimated total expense is placed at $1,500,000, and work will not be commenced in tearing up the streets until Oct. 1, at the earliest.

The Pennsylvania-Delaware boundary line has been surveyed by a joint commission appointed by the legislatures of the two states. The commission will recommend the cession to Delaware of the famous "Flat-iron," or triangular projection of 700 acres between Delaware and Pennsylvania. The first named state has long exercised a quasi jurisdiction over it.

A modern fort and torpedo defense is to be established at old Fort Washington, 13 miles below Washington, D. C., on the Potomac River. The plan includes mines in the river channel, shore torpedo-launching tubes, and emplacement for four 12-in., six 10-in. and three 8-in. modern guns, on lifts and disappearing carriages. At present Washington is only defended against the attack of heavy warships by the guns of Fortress Monroe, at the mouth of Chesapeake Bay.

The Chignecto Ship Railroad is in good condition, having suffered no damage during the cessation of work. But the negotiations for a new contract with Messrs. Dawson, Symms & Usher has failed. Canadian advices say that Messrs. Easton & Anderson, of London, who have the contract for the machinery, will take the place of Meiggs & Sons, as chief contractors, and form a construction company in combination with Canadian contractors to complete the work.

The trolley system is to be introduced into Montreal by the Montreal City Railway Co., on a 30-years' franchise, just granted by the City Council. The company agrees to pay the city four per cent. of its gross earnings up to $1,000,000. The percentage on earnings above that amount to be fixed by a rising scale.

The co-operative plan of profit sharing with its employees is recommended by Pres. M. E. Ingalls, of the Chesapeake & Ohio Ry., in his last reports, as a solution of the growing difficulties of the labor problem. He says:

"The problem of the future in railway managers, while rates are continually going down and wages increasing. A large proportion of the time of your officers and managers is taken up, meeting and consulting and discussing with the organized bodies of labor on the road, the question of wages, etc. Your directors would recommend to the stockholders to consider the plan of establishing a community of interest with the employees. If the company has arrived at a financial position, as your directors think it has, when it can safely be expected to earn its fixed charges and a surplus, they would recommend that the surplus be equally divided with the employees. For instance, if your capital is $60,000,000, and the wages of the employees in the year amount to $5,000,000, let that be the rate of division. If your surplus earnings are $650,000 a year, it would be 1% for the stockholders and 1% for the employees. An employee, then, who had served for the entire year without accident caused by his own negligence, would receive his 1% on the amount of his pay. As the earnings of the company increase, the percentage will be still larger. In any event, the employees would still receive regular compensation, and would also share to some extent in whatever prosperity the company had. Wherever this has been tried in manufacturing companies it has worked well, and has also been successfully adopted on one of the French railways.

A 20,000,000-gallon filtering plant will be built at Philadelphia, at the Belmont pumping station, providing satisfactory bids for constructing the same are received on Sept. 13. The specifications for the plant provide that the rate of filtration shall not exceed 2½ gallons per square foot of filtering material per minute, or 3,600 gallons per day, and that the filtering material shall be not less than 4 ft. of sharp sea sand, sea sand and coke or prepared quartz. The filtered water must not contain more than 0.10 part per million of albuminoid ammonia, 0.015 part of free ammonia, nor more than 100 colonies of microbes per cu. cm. and must not contain any of the coagulant or other purifying agent used. Bidders must guarantee for three years the total cost of filtration per million gallons and must also state the sum for which they will run the plant for one year. Jas. H. Windrim is Director of the Department of Public Works, and John L. Ogden is Chief of the Bureau of Water.

A crevasse at the mouth of the Mississippi is promising trouble to the Eads jetties. The Passe a Loutre, one of the old mouths of the river, has been reopened and the current passing through threatens to deprive the main channel of some of the water necessary to keep it open. New Orleans dispatches say that the United States Engineers do not think the crevasse will damage the jetty channel to any considerable extent, but the Eads company will attempt to close the pass again.

A safety-wall for levees, recently patented by Mr. C. E. Wright, Editor of the Vicksburg "Commercial-Herald," is being commented on favorably by several newspapers in the Mississippi Valley. The inventor proposes to place a wooden heart-wall in the interior of the levee, built of two courses of heart cypress plank, crossed at right angles and well nailed. The wall would extend from the bottom of the muck ditch underneath the levee to within a foot of its top. The object of the wall is to prevent the river at high stages from soaking the portion of the levee back of the wall, thus greatly increasing its resistance, also to prevent crawfish, muskrats, etc., from boring holes through the levee.

The essential defect of the scheme seems to be that sooner or later the timber will decay and its presence will then constitute a danger rather than a safeguard. Doubtless a water and vermin proof heart-wall in a levee would be of great value and would permit considerable reduction in the levee's section, but such a wall should be reasonably permanent, or the breaks caused by its defects might be worse than those which it was designed to prevent. The subject of heart-walls in levees was quite fully discussed in a recent paper before the American Society of Civil Engineers by Mr. Wm. Starling, Engineer of the Greenville Levee District.

The zone system of fares on the Cork, Blackrock & Passage Railway, Ireland, was described in our issue of March 19, 1892, and we are indebted to Mr. J. J. O'Sullivan, General Manager, for a copy of the report for the half year ending June 30, 1892, in which the directors state that the adoption of this system has produced an increased revenue between all the railway stations. But between railway stations where the traffic is mainly of the excursion character, and as such dependent on the weather, the increased number of passengers has not up to the present time compensated for the reduction in the fares. There has been a falling off in the revenue, due to the general depression in trade and the unfavorable weather in May and June.

The scheme for supplying water to Oakland and several other Californian cities and towns from the Blue Lakes, located about 100 miles from Oakland, is again being talked of. It is said that the Blue Lakes Water Co. now owns these lakes and has already in operation canals which supply water to several small towns and also to several mines. No satisfactory details regarding the project are yet available, but it is reported that a pipe line is now being laid to Stockton and that a dam 150 ft. high will be built about 33 miles from Stockton and electricity generated by water power for long distance transmission. The Blue Lakes Water Co. was incorporated in 1890. Its principal officers are: President, T. G. Phelps; Secretary, Daniel E. Hayes; Engineer, W. E. Proctor; Consulting Engineer, Frank Soule, Jr.

The new eight-hour law recently passed by Congress to apply to Government work of all classes seems to have put the Commissioners of the District of Columbia in a quandary. This is owing to the fact that the appropriations for the expenses of the District are very specific, providing, for instance, for four pumping engineers, at a yearly salary of $1,100 each. As the engines in question have to be run throughout the 24 hours, three shifts of engineers will now be necessary and the Commissioners, according to the Washington "Star," do not know where to get the money to pay the extra men.

The Midland Railway, of England, has a total mileage of 1,434 miles, with 52 miles under construction. It has 110 miles laid with four tracks, 21 miles with three tracks, 922 miles with double track, and 381 miles with single track. The system includes all kinds of lines, from main lines through thickly populated districts to rural branches of light traffic. The number of passengers per annum is about 36,000,000, of which 1,000,000 are first-class and 35,000,0000 third class, with a tendency toward the decrease of the first-class, which is largely due to the great improvements in the modern third-class cars and the privileges accorded to that class of traffic.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

CUMBERLAND VALLEY.—The engineers of this company have completed the surveys for the line from Newville to Mt. Dallas, Pa., 62 miles.

PENNSYLVANIA.—John T. Dyer, of Norristown, Pa., has been awarded the contract for extending the Hempfield branch to Cowansburg, Pa., about 4½ miles. —About 8 miles of the Peter's Creek branch from Peter's Creek Station west is now under construction.

SANDUSKY & COLUMBUS SHORT LINE.—This company has marketed $700,000 of bonds, the proceeds of which are to be used in equipping its line from Sandusky to Columbus, O., 108 miles. Ch. Engr., F. J. Aid, Columbus, O.

INDIANA, ILLINOIS & IOWA.—An official of this company writes us that no definite arrangements have yet been made for building the proposed line from Knox to South Bend, Ind.

CONCORD & MONTREAL.—The contract for building the line from Goffstown to New Boston, N. H., 5¼ miles, has been let, the work to be completed in 60 days.

BEDFORD BELT.—About 150 men are now at work on this line from Bedford to Buff Ridge and Limestone, Ind., 12 miles, with a branch 3½ miles long.

Projects and Surveys.

YOUGHIOGHENY CENTRAL.—Chartered in Pennsylvania to build a railway from the Rainy Coke Works, near Dawson, Pa., to the Paul Coke Works near Vanderbilt, Pa. Pres., Thos. J. Mitchell, Connellsville, Pa.

INVERNESS & RICHMOND.—A surveying party is being organized to begin the location between Port Hastings and Port Hood, N. S.

Southern.—Existing Roads.

DALTON & SPRING PLACE.—Pres., F. T. Reynolds, of Dalton, Ga., writes us that this road is projected to run from Dalton to Spring Place, Ga., 8 miles, and that the surveys have all been completed. Ch. Engr., H. C. Hamilton, Dalton, Ga.

MACON, DUBLIN & SAVANNAH.—The "Manufacturers' Record" says: "The Macon, Dublin & Savannah R. R. Co. will, as stated in our last issue, commence at once the construction of its road from Dublin to Savannah. Work will be commenced on the Savannah end of the line in order to comply with the terms of the city's grant, which compels the beginning of the work by Sept. 1. Jas. T. Wright, of Macon, is Gen. Man."

PADUCAH, TENNESSEE & ALABAMA.—Tracklaying on the extension from Hollow Rock to Lexington,

Tenn., begun Aug. 22, and is being rapidly pushed by large forces of men.

GEORGIA SOUTHERN & FLORIDA.—This company has through its receiver, W. B. Sparks, petitioned the Superior Court for permission to borrow $400,000 for the purpose of building a branch road from Tifton to Thomasville, Ga. This branch was in course of construction when the road went into the hands of a receiver, and no work has been done on it for 18 months.

Projects and Surveys.

MONTGOMERY, HAYNEVILLE & CAMDEN.—This company completed its organization on Aug. 23 and it is announced that the contract for grading the first ten miles from Camden, Ala., will be let immediately.

Northwest.—Existing Roads.

DULUTH, PORT ARTHUR & WESTERN.—A press dispatch from Duluth, Minn., says: "The Duluth, Port Arthur & Western Ry. has constructed 70 miles of its line, that much of the track being ironed and ready for use. The construction work is being continued and the line will be built to a point four miles south of the International boundary line this fall. The southerly terminus of the line during the late fall and winter will be the Gun Flint Lake mine, from which 10,000 tons of ore will be shipped over the new line this season. It is reported that this railway company has a contract with the Gun Flint Iron Co. calling for the shipping of 100,000 tons of ore per annum, beginning next spring. It's the general belief at Port Arthur that this line will be pushed on south next season to a connection with the Duluth & Iron Range Ry., at Ely, Minn., and business men there are unanimous in the belief that arrangements have already been made with the Duluth & Iron Range, either for use of the latter's tracks into Duluth for both freight and passenger traffic or for the use of the tracks for passenger trains and a traffic arrangement for handling freight business."

Projects and Surveys.

WINONA & SOUTHWESTERN.—Press dispatches state that work will be begun at once on the extension from Osage to Mason City, Ia., about 20 miles.

SIOUX FALLS & YANKTON.—A press dispatch from Sioux Falls, S. Dak., says: "The prospects for building a new railroad line from Sioux Falls to Yankton, S. Dak., is given new and enlarged significance by the visit of W. L. Hand, of Kearney, Neb., who has just succeeded in effecting an alliance with a local company. The line will include an extension to that point, and become part of the scheme developing, therefore, a route to the Gulf of Mexico. A local company here has already arranged with New York capitalists to take hold of the extension to Yankton and Kearney. The company has similar arrangements for building both northeast and southwest from that point. The two projects are regarded as promising material benefit to Nebraska points."

Southwest.—Existing Roads.

TEXAS CENTRAL.—The engineers of this company are making the surveys for the extension from Ross to Waco, Tex., 12 miles.

MISSOURI, KANSAS & TEXAS.—A press dispatch from Smithville, Tex., dater Aug. 18, says: "Work on the extension between this place and Lockhart is being pushed very rapidly at present. The grade of the entire line is most completed, and the construction train, with a strong force, commenced laying the track last Monday. More than a mile per day will be completed, and trains will run from here to Lockhart, in six weeks from now."

HOUSTON BELT.—This company has placed its bonds, and will soon begin work on its line at Houston, Tex.

TEXAS, LOUISIANA & EASTERN.—Secy. Jas. A. Smyth, Conroe, Tex., writes the "Manufacturers' Record" that this company has resumed construction of its line, and on the 13th began laying 12 miles of steel rails on grade already prepared for same. All bridging will be completed and track laid to crossing of the Houston, East & West Texas R. R., a distance of 15½ miles, by Oct.15.

Rocky Mt. and Pacific.—Existing Roads.

EVERETT & MONTE CHRISTO.—Tracklaying on this road is progressing at the rate of about three-fourths of a mile per day, and about 10 miles are now laid east from Hartford, Wash.

Projects and Surveys.

NORTHEASTERN CALIFORNIA.—This company has been chartered in California to build a railway from Castle Crag, Cal., northwest, a distance of 30 miles. Among the incorporators are D. E. Miles L. D. Brewster, E. C. Lancaster, and others.

Foreign.

MEXICO.—A press dispatch from Chicago, Ill., says: "James L. Gates, of Milwaukee, is at the head of a firm of American capitalists which has secured the contract for the completion of the Coatzacoalcos and Tehuantepec line of the Tehuantepec Mexican National Ry. The building of this branch will give the Mexican Government control of the direct route across the isthmus for the Gulf trade. Fourteen million dollars has been spent on this line by various companies, but it still lacks 150 miles of being completed, and the Government has at last consented to take hold of the work, and carry it through to completion. The agreement specifies that the work is to be completed within three years. Operations will begin within eight months, and in case the work is completed before the specified time the Government will confer a land grant of 8,000,000 acres upon the builders."

HONDURAS.—A correspondent asks if the railway mentioned in our issue of Aug. 18, is to be in British Honduras or Honduras proper. A glance at the map would show him that British Honduras does not extend far back from the east coast, and therefore, offers no chance for an interoceanic line. The project referred to is for Honduras proper, or Spanish Honduras.

GUATEMALA.—It is stated that the contract for building the first section of the Guatemala Northern Ry. has been given to Mr. Sylvanus Miller, of New York city, and his agent, Mr. R. H. May, is now in New Orleans arranging for men and material with which to begin the work. The road is planned to run from Puerto Barrios to Guatemala City, where it will connect with the Guatemala Central and make a continuous line from ocean to ocean. The new road will be 195 miles long.

BRIDGES, TUNNELS AND CANALS.

HACKENSACK, N. J.—Bids will be received until Sept. 7 for a bridge. J. R. Zabriskie, J. C. Van Sann, G. S. Herring, Committee.

SAN ANTONIO, TEX.—The County Commissioners will advertise for bids for the construction of three iron bridges across the Medina River—one at Palatto crossing, one at Man's crossing and one at Garza crossing.

PORTLAND, ORE.—Bids will be received until Sept. 15 for building two bridges to cost $150,000 each.

ELECTRIC RAILWAYS.

BATAVIA, N. Y.—An electric railway 27 miles long to Albion and Oak Orchard Harbor, is projected by D. S. Beckwith, of Albion, and C. M. Gibson, of Barre. It is to be a standard gage line for passenger and freight traffic.

PHILADELPHIA, PA.—The Philadelphia Traction Co. is proposing to try the Love electric conduit system, which is now in use in Chicago. This system was described in our issues of March 19, and April 16, 1892.

MCKEESPORT, PA.—The McKeesport & Wilmerding Street Railway Co. has its surveys nearly completed. The line will be four miles long, with moderately heavy grades. The overhead trolley system will be used, and there will be 4 or 5 cars at the start. Pres., A. M. Smith; Secy. John C. Devany, McKeesport. John R. Romine, of Taylor, Romine & Scott, is the engineer.

MACON, GA.—The Macon Consolidated Street Ry. Co. has let the contract for power station to P. J. Duffy & Sons, at $9,500, and for carshed, 102 × 102 ft., to an Atlanta contractor. The Thomson-Houston overhead electric plant will be used.

NASHVILLE, TENN.—The Overland Ry. Co. has awarded contracts for iron poles, overhead wire, double-deck cars, etc.

VICKSBURG, MISS.—An application for a street railway franchise is being made by C. R. McFarland, Supt. of Water-Works, and E. F. Fuller.

MARQUETTE, MICH.—M. E. Abre is interested in a project for an electric railway to Negaunee, 13 miles distant.

DENVER, COLO.—An electric railway to Golden is projected by Oscar Reuter and Henry Lee.

ELEVATED RAILWAYS.

JERSEY CITY, N. J.—The Penn City Development Co., to build elevated railways, has been organized by J. C. Bacot, of East Orange; A. L. Fairchild, of New York; and E. M. Davidson, of New York. Capital stock, $1,000,000.

PHILADELPHIA, PA.—Work has been commenced on the Quaker City Elevated Ry. Co. Particulars of the financial arrangements were given last week.

CHICAGO, ILL.—The Lake Street Elevated Ry. Co. will be reorganzied under a new charter. Col. A. C. Alberger is one of the directors.

HIGHWAYS.

NEW YORK.—The Highway Commissioners of Oyster Bay have given the contract to Tuomey & Eldart to macadamize the Jericho turnpike, from the Jericho Hotel to the town line, a distance of nearly two miles. The bid was $3.66½ per ft., which will bring the cost of macadamizing the road to a little more than $36,000. The contractors will commence work at once.

NEW JERSEY.—The Hudson County Freeholders have awarded the contract for constructing section No. 1 of the new boulevard, to the Hudson County Construction Co., for $21,140. The contract for building an iron bridge over the New Jersey Central R. R. was awarded to the Wallis Iron Co., for $40,000.

MONTANA.—Proposals for a wagon road, 16 miles long, will be received until Sept. 6 by D. D. Bogart, County Clerk of Missoula Co., Missoula, Mont.

WATER-WORKS.

New England.

CHICOPEE, MASS.—The city officials have adopted the report of Engr. Davis, which recommends a new supply from Cooley and Morton Brooks. The plan provides for a 20-in. main to a reservoir on Keating's Hill, at Chicopee Falls, and a 16-in. main at Chicopee Center. Estimated cost, $117. Sept. 14 the people will vote on buying the property of the recently chartered Willimansett Water Co., which has been offered at a slight advance above cost.

LAWRENCE, MASS.—The Council Committee on Water-Works has recommended that the Council provide for the expenditure of $20,000, for a filtering plant. Probably filter beds will be constructed.

WESTFIELD, MASS.—A new water supply is projected.

Middle.

CHESTER, N. Y.—Sept. 2 the people vote on having works.

DRYDEN, N. Y.—All bids for building works have been rejected because too high. Probably new bids will be asked.

GLEN COVE, N. Y.—It is reported that $50,000 has been subscribed toward the stock of a proposed water company.

NEWTOWN, N. Y.—A franchise has been granted to P. J. Gleason, Mayor of Long Island City.

NEW YORK, N. Y.—The contract for the new Croton dam was awarded Aug. 26 to Jas. S. Coleman, New York, for $4,150,573. The totals of the several bids were given in our issue of last week. Bids for relaying mains on several streets are wanted until Sept. 6 by T. F. Gilroy, Comr. Pub. Wks.

SARANAC LAKE, N. Y.—Sept. 5 the people will vote on building water and sewerage systems at an estimated cost of $30,000.

SYLVAN BEACH, N. Y.—Works are talked of.

ATLANTIC HIGHLANDS, N. J.—Works are projected.

BLOOMSBURY, N. J.—Works are projected with a supply of spring water from a reservoir.

JERSEY CITY, N. J.—Six new boilers may be bought, a reservoir built or completed and a new force main laid from Belleville to the high service reservoir.

MONTROSE, PA.—It is thought that arrangements have been made by which works are assured. John W. Aitken, Carbondale, J. D. Stocker, Jermyn, and Wm. Walker, Mayfield, are interested and will probably organize a company and begin work at once.

PHILADELPHIA, PA.—Bids will be received until Sept. 6 for a locomotive boiler, a Worthington duplex and a Clayton air pump; also until Sept. 13 for building a reservoir at Queen Lane, in the 28th Ward, and for a filter plant at the Belmont pumping station. Jas. H. Windrim, Dir. Pub. Wks.

PHOENIXVILLE, PA.—Bids for $150,000 4½% refunding 5-20-year water bonds are wanted until Sept. 5, 1892. C. S. Yarnall, Com. Ways and Means.

SPANGLER, PA.—The Spangler Water Co. has been incorporated; $2,000; Treas., J. L. Spangler, Hastings.

STATE COLLEGE, PA.—The State College Water Co. has been incorporated; $1,000.

LONACONING, MD.—The water-works election has been postponed to Sept. 13, when a vote on issuing $40,000 of bonds will be taken.

Southern.

PIEDMONT, W. VA.—Works are again projected.

TARBORO, N. C.—The Tarboro Water-Works Co. has been incorporated; $60,000; Chas. C. Burnet, Geo. H. Corey, N. A. Alexander and others.

HARRIMAN, TENN.—Plans and bids for works to cost not over $60,000 are wanted. Address Supervisor Jas. McDowell.

CYNTHIANA, KY.—Bids for the erection and maintenance of works will be received until Oct. 11. Address the Mayor.

North Central.

GLENDALE, O.—Bids are wanted until Sept. 28 for $35,000 of 5%, 30-year water bonds issued to meet the cost of building works. Lewis Shillito, Village Clk.

GLENVILLE, O.—Water may be furnished the village by the city of Cleveland, the village probably putting in distribution.

WEST CLEVELAND, O.—Bids are wanted until Sept. 13 for furnishing 8 to 4-in. cast iron pipe and specials for the ensuing year; also for laying 5,100 ft. of 8-in. cast iron pipe. E. R. Doty, Chn. Bd. Trustees.

NAPANEE, IND.—The new stand-pipe, 70 ft. high, burst last week, seriously injuring Wm. Burns, Supt.

CADILLAC, MICH.—A 30-years' franchise has been granted to the Cadillac Water Co. W. W. Cummer, G. E. Lamb and others are interested. A stand-pipe is proposed. Works were built in 1878.

BELLEVILLE, ILL.—It is reported that the Belleville Water Co. has been incorporated; $350,000; Joseph Fuess, G. W. Dotharding and others.

COLLINSVILLE, ILL.—Bids for works are wanted as stated in our advertising columns.

GLENCOE, COOK CO., ILL.—An effort to secure works is being made in which it is hoped that several other suburbs of Chicago will join.

GRAYVILLE, ILL.—Water and electric lighting plants are projected.

LE ROY, ILL.—The people have voted, 160 to 46, to put in works at an estimated cost of $6,000. Population by last census, 1,258.

NEW RICHMOND, WIS.—It is reported that the contract for works was awarded on Aug. 23 to Fairbanks, Morse & Co., St. Paul, Minn., for $13,960.

TOMAH, WIS.—Engr. E. S. Melay has estimated that works could be b uilt for $36,000, including a reservoir.

Northwestern.

FREMONT, NEB.—The Fremont Foundry & Machine Co. has received the contract for main extensions at $23,601, it being the lowest bidder.

HARRINGTON, NEB.—The Town Board will be petitioned to call an election to vote on issuing bonds for works.

HARVARD, NEB.—Works are talked of.

Southwestern.

LITTLE ROCK, ARK.—The Home Water will begin laying ten miles of mains Sept. 1, it is reported.

CORPUS CHRISTI, TEX.—The Corpus Christi Water Supply Co. has been incorporated; $55,000; N. Gussett, C. C. Heath, F. H. McMullen and others.

CRIPPLE CREEK AND FREMONT, COLO.—These new towns have granted franchises to the Beaver Creek Water Co., which proposes to introduce water from a spring, the "last reservoir to be 300 ft. above the Cripple Creek."

SANTA FE, N. MEX.—It is reported that the Municipal Investment Co., of Chicago, will enlarge the works and will build three reservoirs and lay pipe lines to irrigate 20,000 acres.

Pacific.

FARMINGTON, WASH.—Bonds for works have been voted.

FOREST GROVE, ORE.—The Water Committee has estimated that works can be built for $48,100, including 26,400 ft. 8-in. supply main; 17,400 ft. 8 to 4-in. distributing mains, and two small reservoirs.

MODESTO, CAL.—The town has employed Engr. J. B. Pitchford, of W. T. Garrett & Co., San Francisco, to make plans for works to cost not over $60,000. A special election must be had before the town can build works. A company now supplies water.

SELMA, CAL.—A 55,000-gallon tank on a 60-ft. tower burst Aug. 18, the bottom hoops giving way. Direct pumping will be used until a new tank is built.

Canada.

SYDNEY, N. S.—Bids are wanted until Sept. 15 for $40,000 of bonds to pay for works. The interest will be not more than 4½% and the bonds will be redeemable in 20 years. Colin McKinnon, Mayor; Alex. Campbell, Town Clk.

YARMOUTH, N. S.—The "Herald" states that the town has bought the private works for $235,000 and will add hydrants and a stand-pipe or reservoir at once.

IRRIGATION.

DENVER, COLO.—State Engr. J. P. Maxwell will receive bids until Sept. 16 for building a reservoir embankment and spillway at Boss Lake, Chaffee Co.

WASHINGTON.—It is reported that estimates have been completed for the Wells irrigating canal in the Kittitas Valley, which place its cost at $500,000. As proposed the canal will be 77 miles long and have a

capacity, at its head, of 800 cu. ins. per second. Ch. Engr., H. K. Owens.

SANTA ANA, CAL.—A dam is proposed to store water for the San Joaquin ranch and El Modena Irrigation Co. As projected the dam will be 300 ft. long and 60 or 70 ft. high.

NEW COMPANIES.—Garfield County Irrigation Co., Eminence, Kan.; $100,000; Directors, G. M. D. Goff, Ravanna, P. H. Loomis, Eminence. Cascade Ditch & Irrigation Co., Walla Walla, Wash.; $150,000; G. A. Willard, V. H. Tobin and others; to construct a canal from a point on the Walla Walla River near Dry Creek to Walla Walla.

SEWERS.

SALEM, MASS.—The contract for the Webb St. sewer has been awarded to Bates, Touret & Welch, at $9,743.

SHELBURNE FALLS, MASS.—The Selectmen have decided to construct the village sewer at once. The size is 15-in. and the work will be done by contract.

BATAVIA, N. Y.—The Sewer Commissioners have organized with John F. Lay as President and Edward A. Washburne, Secretary.

COBLESKILL, N. Y.—The Sewer Commissioners will receive bids until Sept. 6 for a system of sewers.

NEW ROCHELLE, N. Y.—Bids will be received at the office of Waring, Chapman & Farquhar, Engrs., 874 Broadway, New York, until Sept. 5 for flush tank, iron pipe work, etc., for sewerage outlet. We are informed by Horace Crosby, Engr., that plans are not yet completed for the extensions for which the village has voted to issue bonds for $75,000, and that contracts will not be ready for one or two months.

NEW YORK, N. Y.—The Commission of Streets for Wards 23 and 24 will receive bids until Sept. 7 for several sewers, including an outlet sewer in Jerome Ave., from Harlem River to Elliot St.

NIAGARA FALLS, N. Y.—Sewer bonds for $50,000 will be sold Sept. 9.

TROY, N. Y.—The Contracting Board will receive bids until Sept. 6 for a brick sewer in Second St., and pipe sewer in four streets.

FREEHOLD, N. J.—The Town Commissioners will receive bids until Sept. 8 for several sewers.

TRENTON, N. J.—The Board of Public Works will receive bids until Sept. 15 for two sewers.

READING, PA.—A contract has been awarded to P. F. Hawman at $13,542.

MACON, GA.—C. W. Hendrick, Cy. Engr., writes us as follows: "I am now engaged in making a plan for a system of sanitary sewers for Vineville, the resident suburb of Macon. We hope this fall to pass a bill through the legislature, authorizing us to issue bonds to build a system for Macon proper. As for street work, we are building quite an extensive system of parks over our city. Our streets being so very wide (some as wide as 180 ft.) gives us an opportunity of doing some very nice work. A gentleman who has traveled a good deal (a stranger) compliments us very highly by saying we have the prettiest work he had seen."

FINDLAY, O.—Bids are asked until Sept. 7 for 1,600 ft. 15-in., 187 ft. 8-in., and 540 ft. 6-in. sewer. J. S. Humphrey, Cy. Engr.

LIMA, O.—The Council has voted to ask the next legislature to authorize the city to issue sewer bonds for $50,000.

FARIBAULT, MINN.—The Council has voted in favor of a sewerage system.

HILLSBORO, MINN.—The Council has decided to establish a system of sewers.

DEADWOOD, S. DAK.—The contract for a sewerage system has been awarded to E. J. Lawton at $39,000.

DAVENPORT, IA.—The contract for 14,393 ft. of 20 to 24-in. pipe and 1,870 ft. 2×3-ft. brick sewers has been awarded to Tschirgi & Kringle, Dubuque, at $35,484.

MEXICO, MO.—The City Engineer is preparing estimates for a system of sewers.

ST. JOSEPH, MO.—The Mitchell Ave. sewer contract has been awarded to Andrew Sheridan at $18 per lin. ft. The contract for 1,100 ft. of sewer to the Asylum building has been awarded to P. Mosley at $9.95 per lin. ft.

ST. LOUIS, MO.—The Board of Public Improvements will receive bids until Sept. 13 for six sewers.

COLFAX, WASH.—W. J. Roberts, Cy. Engr., writes us that the City Council has adopted his plans for a sewerage system to cost $25,000, and that 4,800 lin. ft. to cost about $9,000, will be constructed at once.

SEATTLE, WASH.—The Board of Public Works will receive bids until Sept. 7 for sand and gravel for the Lake Union sewer tunnel, and 1,000,000 brick for the South tunnel.

LOS ANGELES, CAL.—The Council has adopted an ordinance for an 8 to 15-in. sewer in 38 streets.

SAN JOSE, CAL.—Mr. Pieper, Cy. Engr., is preparing estimates for a proposed system of sewers.

STREETS.

PAWTUCKET, R. I.—The Council has appropriated $30,500 for highway work, and $14,000 to macadamize Pine St.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Sept. 6 for repaving 23 streets with granite blocks. Col. J. Y. Culyer, Consult. Engr., has submitted to the Park Commissioners plans for the extension of the Eastern Parkway to the new park adjoining the Ridgewood reservoirs.

NEW YORK, N. Y.—The Commissioner of Streets for Works will receive bids until Sept. 8 for 41 contracts, including 38 for paving with granite blocks. The Commissioner of Streets for Wards 23 and 24 will receive bids until Sept. 7 for 11 contracts for trap rock screenings, curbing, flagging paving with granite blocks, etc.

ROCHESTER, N. Y.—The lowest bid for macadamizing Genesee St. was that of W. H. Jones & Sons, $16,077.

BALTIMORE, MD.—Bids are asked until Sept. 10 for opening, grading and constructing Hudson St., 70 ft. wide, from the eastern limits of the city to the west side of Highland Ave., on Third St. Geo. G. Casey, Jr.

WASHINGTON, D. C.—Bids will be received at the office of Public Buildings and Grounds until Sept. 6 for 1,200 sq. yds. asphalt pavement, 1,000 sq. yds. asphalt walks, and for repairing 1,300 sq. yds. asphalt walks. Col. O. H. Ernst, U. S. A.

TITUSVILLE, FLA.—The city is asking for bids for street paving.

FRANKFORT, KY.—Chas. G. Payne, Cy. Clk., writes us that the Governor has vetoed their street improvement bill, which virtually kills it.

AVONDALE, O.—The Corporation Clerk will receive bids until Sept. 23 for the improvement of two streets.

BOND HILL, O.—The Village Clerk will receive bids until Sept. 26 for the improvement of Carthage Ave.

DAYTON, O.—The City Comptroller will receive bids until Sept. 9 for paving with stone flagging, cement or asphalt, the sidewalks in 14 streets.

FINDLAY, O.—The Board of Improvements will receive bids until Sept. 6 for sidewalks in 22 streets.

WINTON PLACE, O.—The Village Clerk will receive bid until Sept. 8 for artificial stone sidewalks in eight streets.

INDIANAPOLIS, IND.—The Board of Improvements has adopted resolutions for paving several streets with brick.

SEYMOUR, IND.—The Common Council will receive bids until Sept. 15 for establishing grade and graveling one street.

ST. LOUIS, MO.—The Board of Public Improvements will receive bids until Sept. 13 for paving in nine streets with granite blocks, and in ten with Telford paving.

OMAHA, NEB.—The Board of Public Works will receive bids until Sept. 9 for paving with Trinidad asphalt.

ELECTRICAL.

NEW YORK, N. Y.—The Park Commissioners will receive bids until Sept. 7 for furnishing and erecting an electric light plant and wiring and lighting of the north wing of the Metropolitan Museum of Art in Central Park.

WAPAKONETA, O.—The citizens have voted in favor of issuing bonds not to exceed $20,000 to erect a municipal plant.

MARSHALL, MO.—The Mayor has been instructed to receive bids for 40 arc lights of 1,200 c. p. each, contract for one year with a franchise for five years.

MONTREAL, QUE.—The contract of the Royal Electric Co. will expire next year and the Mayor desires to have new bids called for in October of this year. The present price is $140 per light per year and the Light & Power Co. offers to furnish lights at $100 each per year.

NEW COMPANIES.—Dahl Electric Co., Jersey City, N. J.; $500,000; F. H. Leonard, Jr., Syracuse, N. Y.; S. L. Phillips, New York, N. Y.; C. B. Hughes, Jersey City. Hopatcong Hotel Co., Mount Arlington, N. J.; $125,000; J. T. Rossell, Brooklyn, N. Y.; W. C. Culver, Jersey City; F. Randolph, New York, N. Y. El Dorado Gas & Electric Light Co., El Dorado, Kan.; $40,000; A. Gilbert and S. M. Gilbert, Minneapolis, Minn., and W. F. Greene, El Dorado.

CONTRACT PRICES.

IRON PIPE.—Syracuse, N. Y.—Bids were opened Aug. 20 for about 17,500 tons of 30-in. cast iron pipe and specials. There were 11 bidders and separate bids were made for each of four sections, the prices ranging as follows: Straight pipe, $20.12 to $24.25 per ton; curved pipe, $23.80 to $75 per ton; specials, 2 to 3¼ cts. per lb.

Jacksonville, Fla.—The lowest bid for iron pipe for the Cedar St. sewer was that of the Chattanooga Pipe Works, $25.25 per ton delivered f. o. b. for pipe weighing 100 lbs. per ft. and 12 ft. 5 ins. in length.

STREET WORK.—Reading, Pa.—The only bid received for paving in three streets with sheet asphalt was that of the Barber Asphalt Paving Co., $3 per sq. yd. for Trinidad Lake asphalt. They offer to furnish and set granite curbs at $1.25 per lin. ft., and to reset curbs at 13 cts. per lin. ft.

SEWER.—Conneaut, O.—W. M. Judd, Engr., sends us the following prices of the contract which we noted recently as awarded to J. D. Sullivan, Erie, Pa., at $26,448: 5 and 6-in. pipe laid, 12 cts. per lin. ft.; 8-in., 13.2 cts.; 10-in., 17¾ cts.; 12-in., 23¼ cts.; 15-in., 32¼ cts.; 18-in., 42.1 cts.; 20-in., 50.1 cts.; 3, 4, 5 and 6-in. drain tile laid, 3, 5, 5½ and 7½ cts.; excavation to 6 ft. in depth, 17 cts. per lin. ft., with the following prices for each additional depth of 2 ft.: 22 cts., 37 cts., 89 cts., $1.33, $1.47, $2, $2.50; rock trench per ft. in depth, 25 cts.; repaving, 5 cts.; embankment, 25 cts. per cu. yd.; manholes, $37 each; lampholes, $2; flushtanks, $39; iron pipe, $27 per ton.

FILLING.—Springfield, Mass.—The contract for filling Kibbe hollow has been awarded to Sackett Bros. at 50 cts. per cu. yd. The contract calls for the removal of about 6,200 cu. yds. of earth, the contractor to furnish all labor and earth material for the refilling and grading and the upper two feet of the roadway must be of good sand or gravel.

MISCELLANEOUS.

DRAINAGE CANAL.—Chicago, Ill.—The Board of Drainage Trustees will receive bids until Oct. 19 for the excavation of the main drainage channel between Willow Springs and Summit. Proposition 1 includes 11,400,000 cu. yds. of earth, 500,000 cu. yds. of rock and 40,000 cu. yds. of dry rubble walls. Proposition 2 includes 7,285,000 cu. yds. of earth, 350,000 cu. yds. of rock and 40,000 cu. yds. of dry rubble walls.

BUILDING.—Trenton, N. J.—Bids are asked until Sept. 6 for the state building to be erected on the grounds of the World's Columbian Exposition, Jackson, Park, Chicago. W. S. Lenox, Secy., N. J. Com.

EXCAVATING AND CULVERT WORK.—Providence, R. I.—The Park Commissioners will receive bids until Sept. 8 for about 2,000 cu. yds. excavating, from the head of lake No. 1, near Elmwood Ave., building granite culvert head, etc.

BOILERS AND TANKS.—Brooklyn, N. Y.—The Board of Education will receive bids until Sept. 6 for four tubular boilers and four iron tanks; also for heating and ventilating several new school buildings.

MARKET.—San Francisco, Cal.—Rix & Birrill, of this city, are reported to have secured the government contract for rebuilding a large market at Lima, Peru, to cost between $800,000 and $1,000,000. The architect is A. Page Brown, of San Francisco, who has designed an ornamental structure, with spacious colonnades below and loggias around the tower, similar colonades below and loggias around the tower, similar to the tower of Madison Square Garden, New York. This contract is noteworthy as the first which an American firm has secured in Peru in many years, all such work being done by English and German firms.

MASONRY WORK, ETC.—New York, N. Y.—The Board of Park Commissioners will receive bids until Sept. 7 for the excavating, mason work, granite, iron work, skylights, asphalting, carpenter work, plumbing, etc.; also for a boiler-house, engine room, etc., to be erected in Central Park, for the use of the Metropolitan Museum of Art.

LEVEE WORK.—Saint Bernard, La.—The Commissioners for the Lake Borgne Basin Levee District will receive bids until Sept. 15 for 12 contracts.

DAM.—Burnham, Me.—At a town meeting Aug. 22 the town voted to build a new dam on their water power.

DAMS AND SHORE PROTECTIONS.—Rock Island, Ill.—Bids will be received at the U. S. Engineer Office until Sept. 23 for the construction of dams and shore protections as follows: Between Reed's Landing and Minneska, Minn.; Genoa, Wis., and Prairie du Chien, Wis.; Glenhaven, Wis., and Dubuque, Ia.; Dubuque, Ia., and Clinton, Ia.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Rhode Island Locomotive Works, Providence, R. I., are building a number of compound locomotives; they include 5 or 6 two-cylinder engines on the company's system; also 3 double truck, four-cylinder compound engines for the Mexican Central Ry., designed by Mr. F. M. Johnstone, Superintendent of Machinery (Eng. News, March 12 and 26, April 2 and 9); one of Mr. Johnstone's ten-wheel, four cylinder compounds for the Mexican Northern Ry., and another for the Mexico, Cuernavaca & Pacific Ry., and a ten-wheel simple engine for the latter road. The New York Equipment Co. has delivered 6 eight-wheel engines to the Duluth, Mesaba & Northern. The Baldwin Locomotive Works, Philadelphia, Pa., are building 100 tender trucks for the Baltimore & Ohio.

CARS.—The South Baltimore Car Co., Baltimore, Md., is building 1,750 coal and freight cars for the Baltimore & Ohio. The Wisconsin Central will add 30 passenger cars and six sleeping cars to its equipment. The Houston & Texas Central is building 275 platform cars.

RAILS.—The Maryland Steel Co., Sparrow's Point, Md., has an order from the Pennsylvania R. R. for the 100-lb. steel rails referred to in our issue of Aug. 18.

RAILWAY SHOPS.—The Great Northern Ry. has completed plans for the machine and car repair shops, roundhouses, etc., to be built at Spokane, Wash. The machine shop will have a capacity of 75 engines a year, and will employ about 250 men. The buildings are to be finished by 1893.

HYDRAULIC PRESSURE REGULATOR.—In the description of the Acton hydraulic pressure regulator, given on page 171 of our issue of Aug. 25, we omitted to state that the regulator is made by John Acton, 191 & 193 Worth Street, New York, N. Y.

THE RENSSELAER MFG. CO., of Troy, N. Y., has opened an office in the Monadnock Building, Chicago. Mr. Octavius Jones, special representative, who has been connected with the company for several years, is in charge of the office.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., is putting up two iron buildings for the Randolph & Clowes Co., Waterbury, Conn. One is a casting shop, 42×82 ft. long, and the other a pickle room, 25×100 ft. The company is also building, to its own plans, a new gas house for the Philadelphia & Reading R. R., at Philadelphia, Pa., a new retort house for the Geo. H. Morrill Co., of Boston, Mass., and a new boiler house for the Pope Mfg. Co., at Hartford, Conn. All of these buildings are to be of iron.

COMPANIES.—Illinois Railway Construction Co., Chicago, Ill.; W. E. Shaw; J. M. Armstrong and W. P. Dewey. Producers & Refiners Pipe Line Co., Meadville, Pa.; $250,000; Pres., J. W. Lee; secy., S. Y. Ramage. New Jersey Asphalt Co., Newark, N. J.; $125,000; J. A. McClary, E. Berla and S. A. Smith.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $18 for iron and $13.50 for steel. Pittsburg: $30; old rails, $19 to $19.50 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $18 for iron and $13 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes, 2.1 cts; track bolts, 2.6 to 2.65 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 52½% on black and galvanized butt-welded; 70 and 60% on black and galvanized lap-welded. Casing 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $16. Pittsburg: $13.25 to $14.50; Chicago: $13.25 to $15.

LEAD.—New York: 4.1 cts.; Chicago: 3.97 cts.; St. Louis: 3.9 to 3.93 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.9 to 2.1 cts.; steel plates, 1.95 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange; 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 for large lots, and 2.1 to 2.15 cts. for small lots; angles, 1.9 to 2 cts.; tees, 2.45 cts.; Z-bars, 2.15 cts.; universal mill plates, 1.85 to 1.9 cts. for iron and 1.9 to 2 cts. for steel; sheared steel bridge plates, 2.05 to 2.15 cts.; refined bars, 1.7 to 1.75 cts. for iron and steel; steel plates, 1.85 to 1.95 cts. for tank, 2 to 2.15 cts. for shell, 2.1 to 2.2 cts. for flange, 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.3 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2.1 to 2.05 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2.15 to 2.25 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.3 cts. for shell, 2.75 to 3 cts. for flange.